LumaSense™ TECHNOLOGIES

Instruction Manual

3436i
SF6 Detector

BE6039-11

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3436i SF6 Detector

April 2015

Safety Considerations.

Throughout this manual Monitor is used for:
Photoacoustic Gas Monitor – INNOVA 3436i

The Monitor complies with:

- EN/IEC 61010-1, 3rd Edition: Safety requirements for electrical equipment for measurement, control and laboratory use.
- c Nemko US Electrical Safety - UL61010-1
- Can/CSA-C22.2 No. 61010-1-04 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.
- UL Std. No. 61010A-1 (3rd Edition) - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.

SAFETY SYMBOL

The apparatus will be marked with this symbol when it is important that the user refers to the associated warning statement given below.

To ensure safe operation and retain the Monitor in safe condition, note the following:

Power Cord must be detached before removing the enclosure.

EXPLOSION HAZARD! **TO AVOID THE POSSIBILITY OF AN EXPLOSION; MONITORING OF FLAMMABLE GASES IN EXPLOSIVE CONCENTRATIONS MUST NEVER BE ATTEMPTED.**

Never operate the 3436i Photoacoustic Gas Monitor in potentially explosive environments.

When monitoring potentially flammable or toxic gases it is essential that:

- The instrument itself is placed in a well-ventilated area outside the potentially hazardous zone.

- A sufficiently long tube is connected to the air-outlet on the back panel so that the sampled gas is carried away to the open air or to an extraction and/or filtration unit.

-

Environmental Conditions for transport and storage:

Temperature:	-25 to +55ºC
Relative Humidity:	0 to 80% RH
Atmospheric Pressure:	800 to 1060 hPa

Warnings!

- Avoid water condensation in the instrument.

- Switch off all equipment before connecting or disconnecting their digital interface. Failure to do so could damage the equipment.

- Do not position the equipment in a way preventing the ability to unplug the cable on the back-panel.

- Whenever it is likely that correct function or operating safety of the apparatus has been impaired, the apparatus must be made inoperative and secured against unintended operation.

- Any adjustment, maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be carried out only by trained personnel.

- If a fault is reported by the monitor that indicates correct function of the instrument may be impaired, consult your local LumaSense Technologies representative. Under no circumstances should repair be attempted by persons not qualified in service of electronic instrumentation.

- Use of the Monitor in a manner not specified by the manufacturer may impair the protection provided by the equipment

Applying Power

Connecting the mains supply.

The 3436i is operated from 50 to 60 Hz single phase AC mains supply. Voltage 100 to 240 Vac.

Before using the 3436i check that the available mains voltage match the specified voltage and frequency for the instrument.

Use the power Cord delivered with the 3436i. Or check that the Cord used is rated minimum 10A/250V with protective earth.

SAFETY SYMBOLS

Frame or Chassis Dangerous voltage Protective earth

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Considérations de sécurité.

Tout au long de ce manuel Moniteur est utilisé pour désigner:
Moniteur de Gaz Photoacoustique – INNOVA 3436i

Le Moniteur est compatible avec:

- EN/CEI 61010-1, (3e édition): Exigences de sécurité pour appareils électriques de mesure, de contrôle et de laboratoire.
- Nemko C US Electrical Safety - UL61010-1

- CAN/CSA-C22.2 No. 61010-1-04 – Exigence de sécurité pour appareils électriques de mesure, de contrôle et de laboratoire.

- UL Std. No. 61010A-1 (3e édition) – Exigences de sécurité pour appareils électriques de mesure, de contrôle et de laboratoire.

Symbole de sécurité

L'appareil sera marqué de ce symbole quand il est important que l'utilisateur se réfère à la déclaration d'avertissements associés publiée dans le guide d'utilisation

Pour assurer un fonctionnement sûr et garder le Moniteur dans un état de sécurité, noter ce qui suit:

Le cordon d'alimentation doit être détaché avant de retirer le boîtier

Risque d'explosion **Pour éviter tout risque d'explosion; la mesure des gaz inflammables à des concentrations explosives ne doit jamais être tentée.**

Ne jamais utiliser le 3436i Moniteur de Gaz Photoacoustique dans des environnements potentiellement explosifs.

Lors de la mesure des gaz potentiellement inflammables ou toxiques, il est essentiel que :

- L'appareil soit placé dans un endroit bien ventilé hors de la zone potentiellement dangereuse.

- Un tube suffisamment long soit relié à la sortie d'air sur le panneau arrière de sorte que le gaz prélevé soit emporté à l'air libre ou dans une extraction et/ou unité de filtration.

Conditions environnementales pour le transport et le stockage:

Température:	-25 à +55℃
Humidité Relative:	0 à 80% HR
Pression Atmosphérique:	800 à 1060 hPa

Avertissements!

- Eviter la condensation d'eau dans l'appareil.

- Eteignez tous les appareils avant de brancher ou débrancher leur interface numérique. Ne pas le faire pourrait endommager l'appareil.

- Ne placez pas l'appareil de manière à empêcher la possibilité de débrancher le cordon d'alimentation sur le panneau arrière.

- Chaque fois qu'il soit probable que le fonctionnement correct ou la sécurité de fonctionnement de l'appareil a été altérée, l'appareil doit être rendu inopérant et sécurisé contre toute manipulation involontaire.

- Tout ajustement, l'entretien et la réparation de l'appareil ouvert sous tension doivent être évités autant que possible et, si inévitables, doivent être effectués par un personnel qualifié.

- Si une erreur est signalée par le moniteur qui indique qu'un fonctionnement correct de l'appareil pourrait être diminué, consulter votre représentant local de LumaSense Technologies. En aucun cas les réparations ne doivent essayées par des personnes non qualifiées en service de l'instrumentation électronique.

- L'utilisation du moniteur d'une manière non spécifiée par le fabricant pourrait compromettre la protection offerte par l'appareil.

Mise sous tension

Le raccordement sur secteur

Le 3436i est utilisé de 50 à 60 Hz courant alternatif secteur monophasé. Tension 100 à 240 V courant alternatif.

Avant d'utiliser le 3436i vérifiez que la prise de tension secteur disponible corresponde à la tension et la fréquence spécifiées pour l'appareil.

Utilisez le cordon d'alimentation livré avec le 3436i. Ou vérifiez que le cordon d'alimentation utilisé est classifié au minimum à 10A/250V avec terre de protection.

SYMBOLES DE SECURITE

Cadre ou Châssis **Tension dangereuse** **Terre de protection**

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Chapter 1

Using this Manual

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1.1 Introduction

This manual can be used in several ways. The first time users can work their way through the examples in order to get to know this monitoring system. The more experienced users can jump directly to the relevant chapters in order to gain assistance, and experts can use this manual as a reference book by using the index.

The monitor can be operated in different ways; Online Monitoring using LumaSoft Gas Single point 7810, Online Calibration and back-up using the Calibration Software BZ7002, Offline using the Offline Software BZ7003 , and as a Stand-alone instrument. This manual focuses on the Stand-alone use. For instruction in the use of BZ7002 and BZ7003 please refer to the User Manuals BE6034 and BE6035 respectively.

1.2 Online Monitoring

LumaSoft Gas Single Point 7810 is supplied with the instrument. This is to be used for Online monitoring (PC use) please follow the instructions in the BE6027 User Manual for online monitoring and set-up.

1.3 PC Use BZ7002 Calibration Software

The BZ7002 Calibration Software is used for calibration of the gas monitor from a PC. Please refer to the BZ7002 User Manual BE6034 and Chapter 12 of this Manual.

1.4 PC Use BZ7003 Offline Software

Data from the display memory can be copied to the background memory after a measurement task is performed. The BZ7003 Offline Software is used for upload of these measurement data from the monitor to the PC in either excel format or text format files. Please refer to the User Manual BE6035 and Chapter 9 of this manual for further instructions.

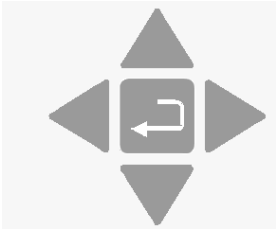
1.5 Stand-alone Use

In some situations, it may be necessary to set up without connecting it to a PC. The procedure to do this are covered in this manual under the Stand-alone use headings. The way these instructions are presented is shown below:

The display above is used continuously through-out this manual. It assists you displaying the text on screen and by indicating which of the push-buttons can and should be pressed.

In general, the push-buttons shown above are used to navigate through the various modes possible within the 3436i but are described in more detail below:

These push-buttons are illustrated as S1, S2 and S3. On the 3436i they correspond to the key and their position on the instrument.
These select push-buttons enable you to select one of the options displayed.



This group of 5 push-buttons are referred to in this manual collectively as the direction keys. The symbols below are used to simplify the instruction in this manual.

▲ & ▼ enable you to increase & decrease numbers, respectively, or to go to the Previous & Next Displays, respectively.

◄ & ► enable you to move across number fields or go to the Previous & Next gases, respectively.

↵, depending on the situations, acts as an “Enter” or “Go To Head” key.

Memory Function push-buttons are always represented with the name of the push-button enclosed in a box which is shaded-in.

SYSTEM Text that appears on the display screen is shown in an open shaded box, using UPPER case letters.

FORMAT **System** ***General*** ***Clock***

When referring to any part of the Set-up “tree”, the text is shown in open shaded boxes with the same typeface as that used in the “tree”.

Chapter 2

Preliminary Tasks

April 2015

When taking delivery of the 3436i SF6 Detector, five very important and preliminary tasks must be completed before starting to operate it:

Install the BZ7002 Calibration Software to enable operation Back-up of the calibration file supplied with the instrument if calibrations are performed by LumaSense Technologies A/S.
Connect the Monitor to a PC (see section 2.1).
Check/Change the fuses in the monitor (see section 2.2).
Set the Communication parameters. USB (see section 2.3), RS232 (see section 2.4), Ethernet (see section 2.5).
Set-up the password protected user levels (see section 2.6).

2.1 Connecting the Monitor to the PC

The monitor comes complete with a USB interface cable. The maximum length of an USB cable is 5 meters. USB extension kits can be used to extend the USB connection to 30 meters.

The gas monitor can also be connected to a PC using a 9-pin to 9-pin null modem RS-232 interface cable (optional accessory WL950-003).

Finally the monitor can be connected to a PC using the Ethernet network connection.

2.1.1 Fitting the RS-232 Cable.

Ensure that both the monitor and the PC are switched off at the mains. Failure to do so may result in your equipment being damaged.
Locate the serial port at the back of the PC; refer to your PC manual if in doubt.
Push the connector on the RS-232 cable on to the serial port socket, and secure it firmly using the securing screws.
Locate the output labelled “RS-232” at the back of the Monitor.
Push the connector at the other end of the RS-232 cable on to this socket, and secure it firmly using the securing screws.
Turn on the PC. Wait for Windows to start up.

The instruments can be turned on at the mains now.

2.1.2 Fitting the USB Cable.

The gas monitor can be connected to an USB port on the PC in order to make measurements using the LumaSoft Gas Single Point 7810 PC application, which communicates using the USB interface communication protocol.

The USB interface cable can be connected while the gas monitor is switched on.

Connect USB interface cable only to Class III equipment.

2.2.3 Fitting the Ethernet Cable.

The gas monitor can be connected to a local Ethernet network in order to make measurements using the LumaSoft Gas Single Point 7810 PC application, which communicates using the TCP/IP network interface protocol or to view the homepage of the gas monitor in a standard PC internet browser.

The Ethernet network cable can be connected while the gas monitor is switched on.

Connect a standard Ethernet network cable to the Ethernet socket connector on the back of the gas monitor. Connect the other end of the Ethernet network cable to your local network. The yellow LED on the Ethernet socket connector will lit, if a local network connection is detected.

2.2 Checking / changing the Fuses in the Monitor.

Unplug the Monitor from the mains power supply and pull out the plug in the AC Mains socket of the Monitor
If the fuses in the Monitor are blown it can indicate a serious fault in the instrument, therefore it is advisable to contact your LumaSense service representative before changing the fuse!

2.2.1 Checking / changing the Fuses in the 3436i

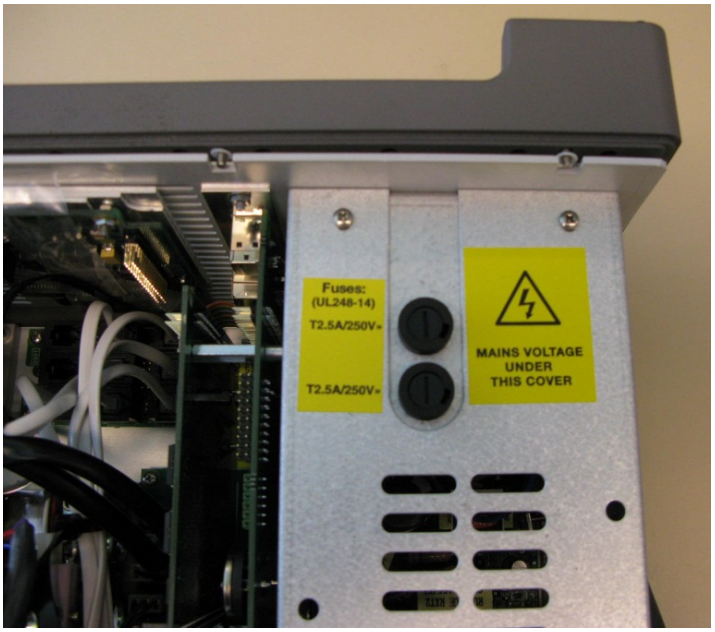
1. Turn the 3436i so that it stands on its back panel and remove the rubber “shoes” mounted on the four “feet” of its base-plate.
2. Using Pozidrive screwdriver No. 1, undo and completely remove the screws located under the rubber “shoes” which have just been removed.
   Note: these screws hold the upper and lower covers of the 3436i together. If the screws are not completely undone you will not be able to remove the upper cover as explained in step 5.

3. Undo the upper four screws holding the frame over the back-panel of the 3436i using Pozidrive screwdriver No. 0.

4. Using the Pozidrive screwdriver No.0 undo the upper four screws which hold the frame over the front panel of the 3436i.

5. Gently lift off the upper cover of the 3436i by pulling it firmly upward.

6. Use a screwdriver to remove the fuse-holder:



7. Remove the old fuse from the holder and replace it with a new. Check that the fuse has the correct rating.

The fuse must be:

Certified Slow-blow (T) fuse with a rating of 2.5 AL, 250 VAC, 5x20 mm.

LumaSense order number: VF0102A

8. Install the fuse-holder and re-assemble the 3436i again.

The figure below shows the inside of the top cover of the 3436i. Note that the front side of the cover has square flanges. Place the top cover back in its correct position on top of the 3436i and screw in the all screws.

2.3 Setting the USB Communication Parameters

The LumaSoft Gas 7810 application with USB communication is able to communicate with the 3436i gas monitor through a USB cable.

BZ7002 and BZ7003 applications with USB communication are able to communicate with the 3436i gas monitor through a USB cable .

No setup on the 3436i gas monitor is necessary in order to be able to communicate with the 3436i gas monitor through an USB connection.

2.4 Setting the RS-232 Communication Parameters

2.4.1 Default RS-232 Communication Parameters.

The Default RS-232 Communication parameters are shown in the table below.

Baud rate	9600
Stop bits	1
Data bits	7
Parity	Even
Hardwire mode	Leased line
Handshake type	Hardwire
Text Line Terminator	CR-LF

Performing a full reset will set all parameters to the default settings.

2.4.2 Checking/Changing the RS-232 Communication Parameters

The communication parameters for the serial interface must be set using the push-buttons on the front of the monitor.

1. Press **SET-UP** **S3** **S1** **S3** **S1** .The screen display now shows the following text.

If the baud rate displayed is incorrect press ↵ and use ▲ and ▼ to display the correct value. Press ↵ again to store the selection.
If the baud rate displayed is correct, then press ▼ to continue to the next parameter.
Press **S1** to select 1 STOP BIT.
Press **S1** to select 7 DATA BITS
Press **S2** to select EVEN PARITY
Press **S3** to select LEASED-LINE
Press **S3** to select HARD-WIRED HANDSHAKE.
Press **SET-UP** to exit the set-up mode
Press **RESET** and **S1** in order that the new settings are enabled.

2.4.3 Checking/Changing the Text line Terminator.

The Text line Terminator must be set using the push-buttons on the front of the monitor.

Press **SET-UP** **S2** ▼ ▼ ▼**S3**

Press **SET-UP** to exit the set-up mode

2.4.4 Checking/Changing the Data Log and Error Log Options.

The Data Log and Error Log must be set using the push-buttons on the front of the monitor.

Press **SET-UP** **S3** **S1** **S1** **S3** ▼**S1** **S1**

Press **SET-UP** to exit the set-up mode

2.5 Setting the Ethernet Communication Parameters

The LumaSoft Gas 7810 application with Ethernet communication is able to communicate with the 3436i gas monitor through a local Ethernet network.

The homepage of the 3436i gas monitor can also be displayed in a web browser, when the 3436i gas monitor is connected to a local Ethernet network.

2.5.1 Checking/Changing the Ethernet Communication Parameters

The communication parameters for the Ethernet interface can be set by using the push-buttons on the front of the monitor.

1. Press **SET-UP** **S3** **S1** **S3**. The screen display now shows the following text.

SELECT COMMUNICATION SET-UP BRANCH		
RS232	**Ethernet**	**Connections**

2. Press **S1** to enter the Ethernet setup. During this setup you can also use the ▲ and ▼ keys to go back and forth between the

available Ethernet settings. The screen display now shows the following text.

IS 3436i'S IP ADDRESS SET BY DHCP ?
NO YES

3. Here you can select whether the IP address of the 3436i gas monitor is to be assigned by a DHCP server in the local network. If you want the 3436i's IP address to be assigned by the DHCP server press the **S3** (Yes) key, where after you will proceed to the below step 6 as the IP address is set by the DHCP server. If you want yourself to set the IP address of the 3436i press the **S1** (No) key. The screen display now shows the following text.

3436i 'S IP ADDRESS 192.168.000.200
PRESS ENTER TO CHANGE VALUE

4. Here you can change the IP address of the 3436i gas monitor in case the IP address is not set by a DHCP server in the local network. If you want to change the IP address, press the ↵ key. If the IP address does not need to be changed, press the ▼ key and you will proceed to the below step 6.
   If you selected to change the IP address, the screen display now shows the following text.

3436i'S IP ADDRESS 192.168.000.200
CANCEL DEFAULT

5. Here you can change the 4 individual numbers in the IP address by using the ▲ and ▼ keys. Each of the 4 individual numbers can be set in the range from 000 to 255.
   You can step between the 4 individual numbers in the IP address by using the ◄ and ► keys.
   In case you want to return to the start value of the IP address press the **S1** (CANCEL) key. In case you want to return to the default stored value of the IP address press the **S3** (DEFAULT) key.
   When you have set the IP address, press the ↵ key. The screen display now shows the following text.

3436i'S IP PORT NUMBER: 23
PRESS ENTER TO CHANGE VALUE

6. Here you can set the IP port number for the Ethernet communication. This normally does not need to be changed. If you want to change the IP port number press the ↵ key. If the IP port numbers does not need to be changed, press the ▼ key and you will proceed to the below step 8. If you selected to change the IP port number the screen display now shows the following text.

3436i'S IP PORT NUMBER: 23
CANCEL DEFAULT

7. Here you can change the IP port number by using the ▲ and ▼ keys. The port number can be set in the range from 0 to 32767.
   In case you want to return to the start value of the IP port number press the **S1** (CANCEL) key. In case you want to return to the default stored value of the IP port number press the **S3** (DEFAULT) key.
   When you have set the IP port number, press the ↵ key. The screen display now shows the following text.

PROTECTED IP ADDRESS 000.000.000.000
PRESS ENTER TO CHANGE VALUE

8. In case you want the 3436i gas monitor to be able to communicate only with a certain PC on the local network, you can set the IP address of this PC as the protected IP address. This can be desired due to security reasons so no other PC is able to communicate with the 3436i gas monitor.
   If no protection is desired the protected IP address should be set to a value of 000.000.000.000.
   If you want to change the protected IP address, press the ↵ key. If the protected IP address does not need to be changed, press the ▼ key and you will proceed to the below step 10.
   If you selected to change the protected IP address the screen display now shows the following text.

PROTECTED IP ADDRESS 000.000.000.000
CANCEL DEFAULT

9. Here you can change the 4 individual numbers in the protected IP address by using the ▲ and ▼ keys. Each of the 4 individual numbers can be set in the range from 000 to 255.
   You can step between the 4 individual numbers in the protected IP address by using the ◄ and ► keys.
   In case you want to return to the start values of the protected IP address press the **S1** (CANCEL) key. In case you want to return to

the default stored value of the protected IP address press the **S3** (DEFAULT) key.
When you have set the protected IP address, press the ↵ key.
If you previously selected that the IP address was NOT to be set by the DHCP server you will proceed to the below step 11.
If you instead selected that the IP address to be set by the DHCP server, the screen display now shows the following text.

CURRENT DHCP ADDRESS 192.168.000.062 **ACCEPT**

10. Here the IP address of the 3436i, which has been assigned by the DHCP server, is displayed. This IP address can be used to manually set Ethernet communication in a PC application, which accesses the 3436i gas monitor.

Press the **S2** (ACCEPT) key to accept.

11. This concludes the setup of the Ethernet parameters of the 3436i gas monitor.
Press the **SET-UP** key to leave the setup.

2.5.2 Display the Homepage of the Monitor

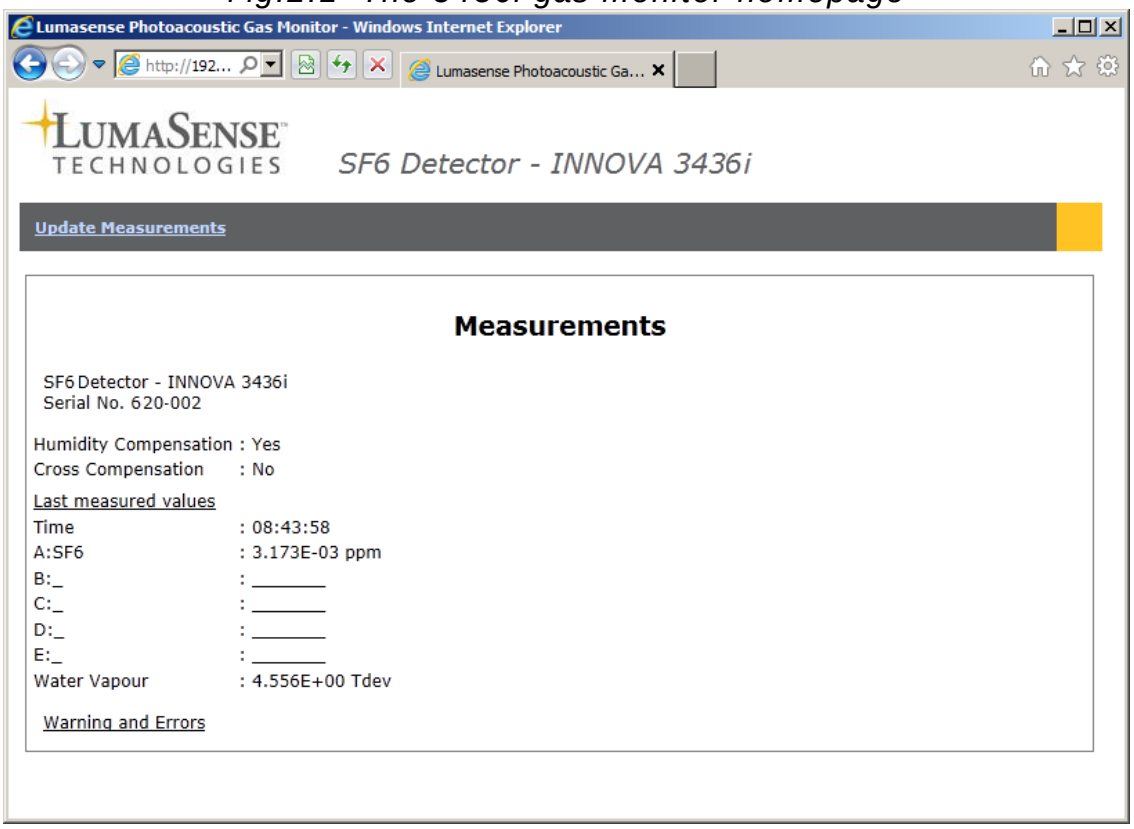
The homepage of the 3436i gas monitor can be displayed if the gas monitor is connected to a Ethernet network.

In section 2.5.1 it is explained how to set-up the Ethernet parameters in the 3436i gas monitor.

Any web browser can be used to display the homepage of the gas monitor. The IP address obtained from the Ethernet set-up of the 3436i gas monitor, can be entered in the address field of the web browser in order to display the homepage.

The last measured gas values are displayed together with information about the gas monitor, like the device serial number, if water compensation is performed.
Error and warning messages (see Chapter 14 for further details) will also be displayed on the homepage.
The grey **"Update Measurements" link** can be used to update the homepage with the last measurement results.

Fig.2.1 The 3436i gas monitor homepage



2.6 Setting-up user Levels

Press the **Lock** function push button on the front of the Monitor.
This enables setting up 3 different user levels, Level 1, Level 2 and Level 3.
These user levels are password protected.

Level 1 is the *Operator* level, which enables start/stop and reading of measurement results. Partial Reset is possible.
Level 2 is the *Expert* level, which in addition to Level 1 access enables set up of parameters. Full Reset is possible.
Level 3 is the *Super-User* level, which allows all possible operations including calibration.

2.6.1 Default settings for User Level and Password.

Before dispatch from the factory the User Level and the Password are set to the following default setting.

User Level 3

And the default setting for the Password is:

Password: ***** (5 times *)

These settings are to be used to change user level or password the first time.

2.6.2 Changing the Password

In order to change the Password Press the **Lock** function push button on the front of the Monitor.

The following text is displayed.

CURRENT USER LEVEL IS X	
CHANGE USER LEVEL	**CHANGE PASSWORD**

Press **S3** "CHANGE PASSWORD"

The following text appears.

ENTER PASSWORD "******"	
PRESS ENTER TO CHANGE VALUE	

1. Press ↵ to change value.

The following text appears.

ENTER PASSWORD "******"	
CANCEL	**DEFAULT**

2. Enter the old Password using the ▲ and ▼ keys.

3. Press ↵.

The following text appears.

PASSWORD IS "******"
PRESS ENTER TO CHANGE VALUE

4. Type in the new Password using the ▲ and ▼ keys.

5. Press ↵.

2.6.3 Changing the User Level

In order to change the User Level Press the **Lock** function push button on the front of the Monitor

The following text is displayed.

CURRENT USER LEVEL IS X
CHANGE USER LEVEL CHANGE PASSWORD

1. Press S1 "CHANGE USER LEVEL"

The following text appears.

ENTER PASSWORD "******"
PRESS ENTER TO CHANGE VALUE

2. Press ↵.
3. Enter the current Password using the ▲ and ▼ keys.
4. Press ↵.

The following text appears.

CURRENT USER LEVEL IS X
PRESS ENTER TO CHANGE VALUE

5. Press ↵.
6. Use the ▲ and ▼ **keys** to change the User level.
7. Press ↵.
8. Press the **Lock** function push button to exit.

2.7 Restoring of calibration data

If you have ordered a calibration from our calibration laboratory, you will receive a CD with a backup of the calibration data. It is very important that you store these data in your Calibration Software BZ7002. Please store the data before using the Gas Monitor. Please refer to the User Manual BE6034 regarding this procedure.

Chapter 3

Philosophy of Operation

April 2015

The monitor has several essential operational features, which enable you to operate it without undue reference to this Instruction Manual. The main features of the monitor which ensure its simple and easy operation, are listed below:

- The fully, comprehensive Software BZ7002 and BZ7003.
- The LumaSoft Gas Single Point 7810 application software.
- The short, self-explanatory texts, which appear in the monitor display when the monitor is being used, give operational guidance to the user.
- The small light-emitting diodes at some of the push-buttons allow the user to identify how the monitor is operating at any particular time.
- Audible warnings “beep” if any push-buttons are used in the wrong way.

3.1 PC Use – Online

A monitoring system, where you use the PC environment to set-up the monitor prior to measuring, display measurement data on the PC screen while monitoring and store the measurement results directly on the PC’s hard disc. The LumaSoft Gas Single Point 7810 application software is used for making online measurements. The measurement results can be used by other programs that fetch data from the SQL Server Express database server featured by the 7810 application. A manual BE6027 for the 7810 application is available for reference.

Using the online mode (7810 Application Software) provides you with a variety of Software Alarm options. Not only are the alarm trigger levels definable, but the action resulting from an alarm being triggered can also be defined here. This enables you to connect external warning systems to the monitoring system.

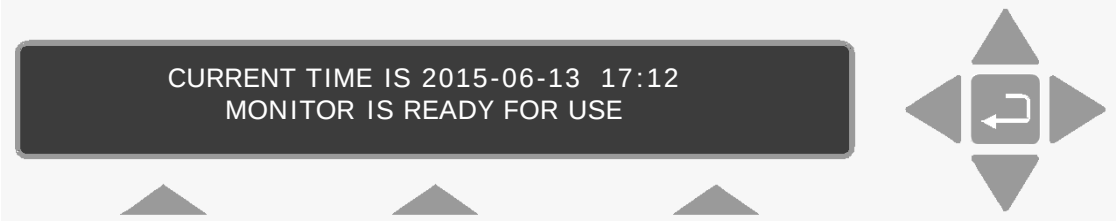
The philosophy behind the 7810 Application Software is common to almost all Windows programs. Access to the various levels of the program is gained by use of the MENU BAR, PULL-DOWN MENUS, NEW WINDOW options and INDEX-CARD separators. These familiar procedures, together with the simple software structure, make the instructions in the On-line sections of this manual understandable and easy to implement.

3.2 Stand-alone Use

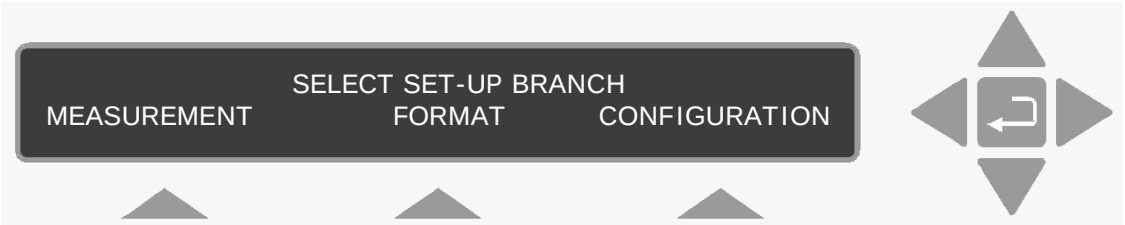
This method of operation is available to those of you who wish to use the monitor without connection it to a PC. The monitor is set-up and the results are displayed via the monitor's front panel.

The structure of the monitor set-up can be viewed like an inverted tree. The main branches divide and separate into minor branches. These in turn divide again and again.

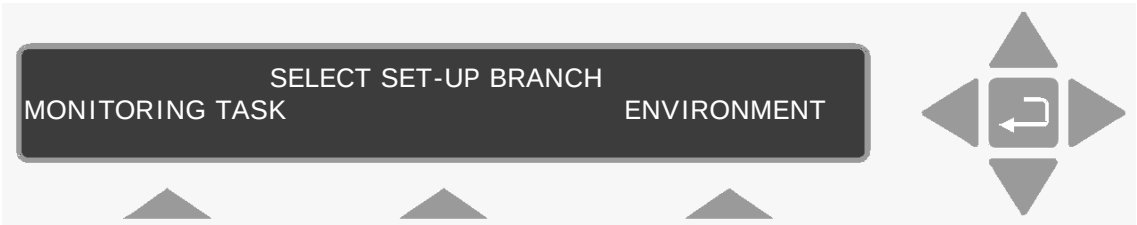
To move through the tree, the branches are selected using the "select" push-buttons (see section 1.5). Use the Set-up Tree, supplied with the monitor and the example steps below to see how the instructions progress. Starting from the initial screen display.



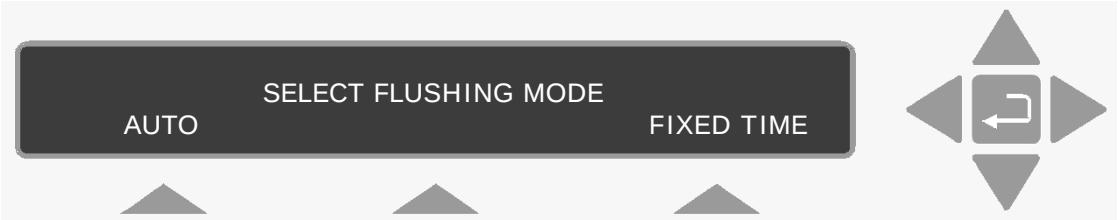
1 Press **SET-UP**, and the text changes to that displayed below.



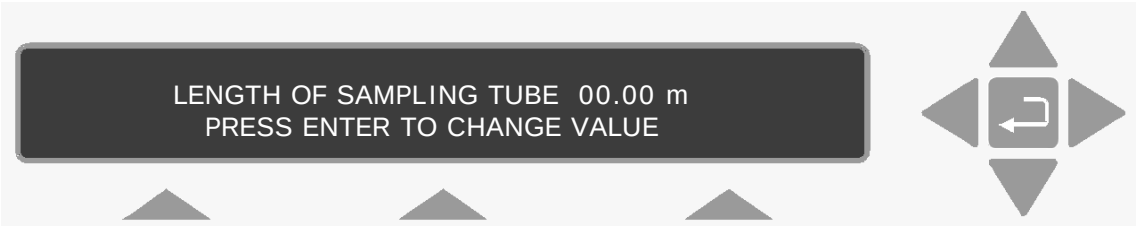
1. To select the **MEASUREMENT** branch, press **S1**. (Pressing either of the other "select" push-buttons will take you along another branch of the set-up tree. The following text is displayed.



To select the **ENVIRONMENT** branch, press **S3**. The text is displayed.



2. To select the **AUTO** flushing mode, press **S1**. The following text is displayed.



This branch does not divide again. At this stage you are able to define the parameters in this branch of the tree using the direction push-buttons.

If the branch had divided again, it is a simply process of using the correct “select” push-button to continue down the desired branch.

Parameters that are already selected are displayed either with a cursor under the current selection or the value is displayed on the top line.

When the correct value or parameter is already selected, you can continue on through the tree using the ▼direction push-button.

To exit SET-UP mode press **SET-UP**

Defining parameters is covered in section 6.1.

The procedures in the example above are common to all the situations where the “select” push-buttons can be used to access the different levels in the monitor.

Chapter 4

Introduction to and Familiarization with the Monitor

April 2015

The Monitor is an extremely versatile measuring instrument, which can be used to perform almost any kind of monitoring task. Its versatility may appear overwhelming at first, but to avoid such a reaction, we suggest that you read this chapter thoroughly, and follow the practical exercises, which are included. These exercises give you a “guided tour” through a number of different practical procedures – monitoring task; performance of a monitoring task; scrolling through data after completion of a monitoring task. By following these different procedures the Monitor operating philosophy will become apparent and you will be able to quickly familiarise yourself with its operation and control.

4.1 Special Terminology

Certain terms are used to describe the operation of the Monitor and it is necessary to fully understand what these terms mean before you start any practical exercise with the Monitor.

4.1.1 Measurement Cycle

A description of a measurement cycle is given on page 2 of the Product Data Sheet (see boxed-in text and schematic diagram of the measurement system of the Monitor). “Measurement Cycle” is the term used to describe everything that takes place in the Monitor from the time the pump starts to flush out the “old” gas sample in its analysis cell, until the signal in the measurement chamber has been measured using the last relevant optical filter.

The time taken to complete a measurement cycle is dependent upon the following factors:

The sample integration time selected – longer measurement times provide greater accuracy.
The flushing times selected for the measurement chamber and the tube as well as the length of the sampling tube attached to the Monitor’s air-inlet – the longer the tube, the more time is needed to flush it out between measurement cycles.
The cleanliness of air-filters which filter the air drawn into the cell (this affects the pumping time required to draw a fresh air sample into the analysis cell).
The degree of fluctuation in the concentration of the gas measured in consecutive measurement cycles (this affects the time required to adjust the gain of the amplifier attached to the microphones).

Table 4.1 gives some indication to the measurement times depending on the number of gases measured and the measurement times selected. However, these times may vary from one measurement

cycle to another due to the cleanliness of the filters and the degree of fluctuation in the concentration of the various gases.

Table 4.1 Approximate measurement times

Monitor Setup	Volume of Air	Response Times
S.I.T.: “Normal” (5s) SIT : “Low Noise” (20s) Flushing: Auto, (tube 1m)	140 cm^3/sample	One gas: ~27s One gas +water ~40s One gas +water ~70s
S.I.T.: “Fast” (1s) Flushing: Chamber 4s, Tube “OFF”	20cm^3/sample	One gas: ~13s One gas + water ~22s

4.1.2 Monitoring Task

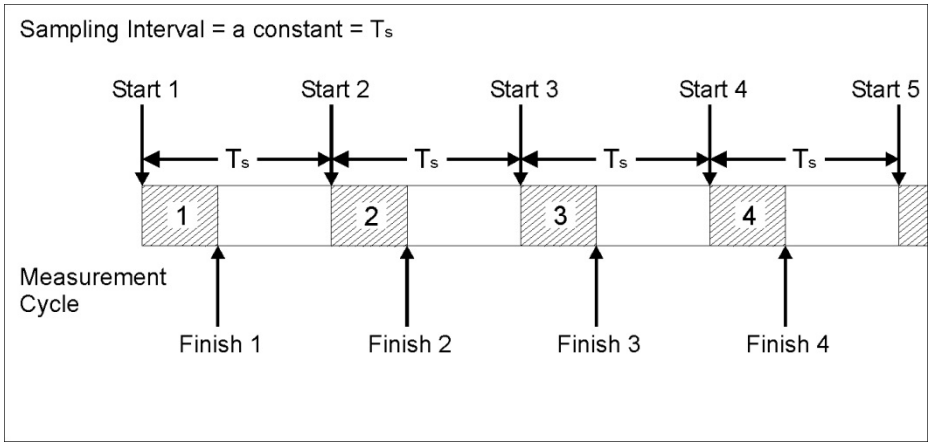
A monitoring task consists of a series of similar measurement cycles. These cycles can either be repeated at regular intervals or be continuous:

4.1.3 Sampling Interval

The sampling interval is a measure of the time between the start of one measurement cycle and the start of the following measurement cycle.

When the Monitor is **not** sampling continuously the sampling interval has to be defined by the user and is a fixed period of time (see Fig.4.1).

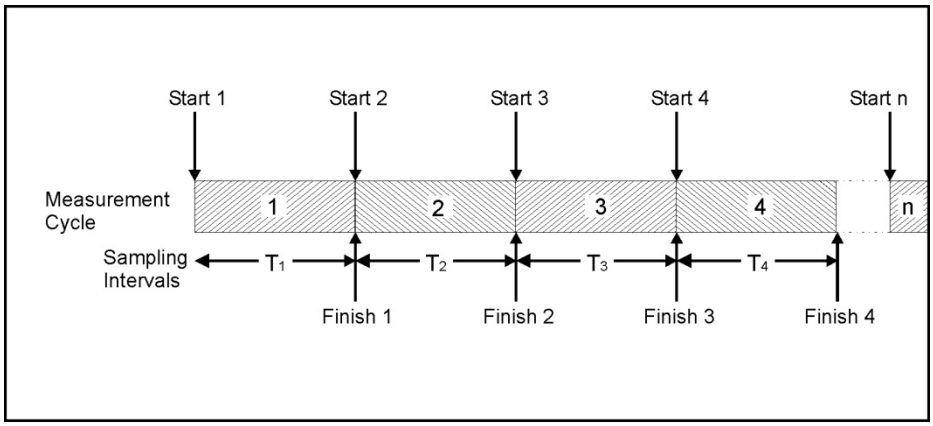
Fig.4.1 An illustration of the fixed sampling intervals of the monitor when it is not sampling continuously.



4.1.4 Continuous Sampling

The Monitor is said to be sampling continuously when each measurement cycle is followed immediately by another similar measurement cycle (see Fig.4.2).

Fig.4.2 An illustration of continuous sampling



4.1.5 Monitoring Period

The monitoring period is the time between the **start** of the first measurement cycle in a monitoring task and the **finish** of the final measurement cycle in a monitoring task.

The monitoring period can either be pre-set by the user – in which case the Monitor automatically stops monitoring after the monitoring period is over – or, **not** pre-set – in which case the Monitor will continue to monitor until the user stops the monitoring task manually (see section 4.3.8).

The maximum time you can set a pre-set monitoring period to be is 7 days. If you try to enter a greater number of days, the Monitor will automatically change the period to 7 days. However, if you do not set a pre-defined monitoring period, the Monitor will just store as much data as possible before starting to overwrite the “oldest” stored measurement results.

4.2 Attaching the Sampling Tube and External Filter

1 Cut a short section of sampling tube of Poly-Tetra-Fluoro-Ethylene (Teflon) tubing, (optional accessory).

2 Using Fig.4.3 and the instructions below, attach one end of this tube to the air-inlet stub on the back-panel of the Monitor.
Push one end of the Teflon tubing through the non-threaded end of the nut.
Hold the end of the tubing between the fingers and gently push the tubing over the end of the Monitor’s air-inlet stub as far as it will go.
Note: if the tubing is bent/broken during this procedure, remove the tubing from the stub and repeat this step using an undamaged length of tubing.
Screw the threaded-nut firmly onto the end of the air-inlet stub.

Fig.4.3 Attaching tubing to the air-inlet stub and the external filter

Outlet
Change filter paper regularly
Do not touch inside of air-filtration unit
Use tweezers and gloves when changing filter paper

3. Attach the other end of the sampling tube to the external air-filter which is provided as an optional accessory.

4.3 Familiarization with the Monitor using the Front Panel

4.3.1 Setting the Internal Clock

Before dispatch from the factory, the internal clock of the Monitor is set to the correct local (Danish) time. If the monitor is to be used as a stand-alone instrument, then the clock can be adjusted to your local time using the following instructions.

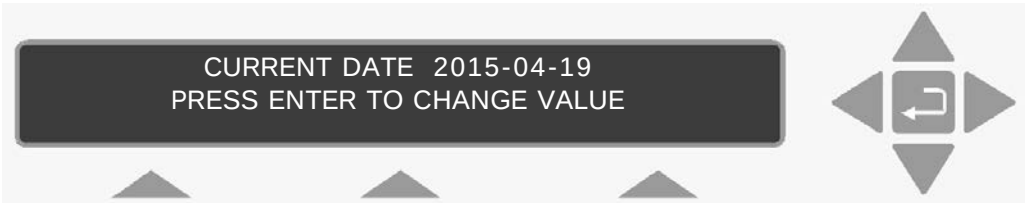
1. Switch on the AC Mains power switch on the back-panel of the Monitor.

2. Press **SET-UP**.

Refer to the Set-Up Tree, supplied with the Monitor, so that you can follow your movement through the various branches of this “tree” in the following sequence of button presses.

3. Press **S3** **S1** **S1** **S1**.

The following screen picture appears:



Dates are entered as the Year-Month-Day, for example the 19th April, 2015 has to be entered as 2015-04-19.

4. To change the date, press ↵.

5. Use the direction keys to enter the correct date.
   Note: press **S1** to revert back to the original date.

6. Press ↵ to accept date.

   This causes the text on the display screen to change to the following:

7. To change the time, press ↵.

8. Use the direction keys to enter the correct time. If you make a mistake in entering the correct date just press **S1** and start again.

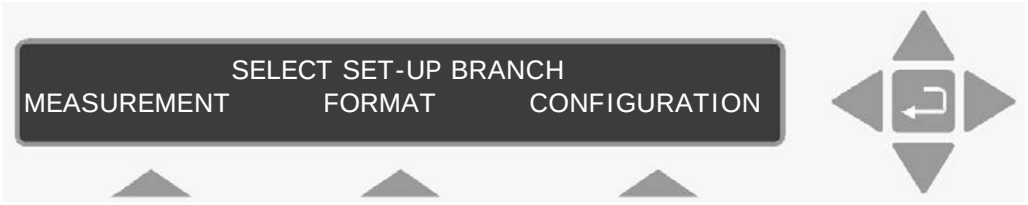
The current time is entered as the time read on a 24-hour digital clock. For example, 13:45 is 15 minutes to 2 o'clock in the afternoon.

9. Press ↵ to accept time.

When this step is completed, the display then moves to the **previous** head of the Set-Up Tree.

10. Press ▲ three times and follow the path you take *en route* through the Set-Up Tree.

The screen display shows the following text:



11. Press **SET-UP** to exit.

4.3.2 Setting Units

All data in the Monitor is stored as raw data. The different units, which you can select here, enable you to enter gas concentrations and to display temperatures, lengths and pressures in units, which you are comfortable with. These units are also used to present measurement data in a form that is most convenient for you.

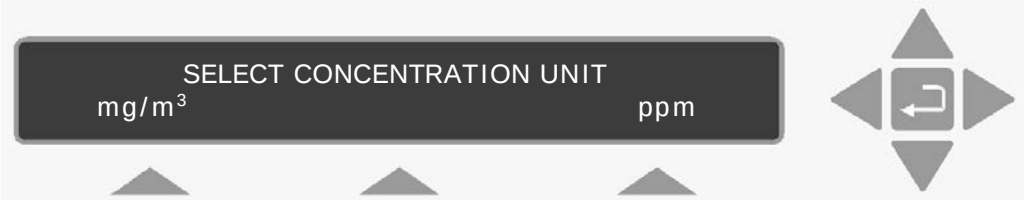
The Monitor can display gas concentrations either in absolute units of mg/m3 unit that is dependent on a particular temperature, termed the **normalization** temperature, or in units of parts per million (by volume) – which is independent of the temperature of the gas. You can inform the monitor about the units you intend to use – for example: the length of the sampling tube attached to the Monitor's inlet (in meters or feet) atmospheric pressure (kPa or mBar or mmHg) and unit for humidity (ppm or Tdew or kPa or mg/m^3).

The measurement units can be changed using the push-buttons on the front of the monitor:

1. Press **SET-UP**.

2. Press **S3** and then **S2**.

The following text appears on the screen display:

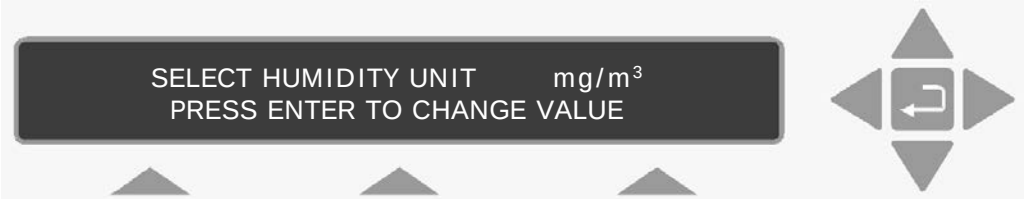


The cursor appears under the unit which is presently in the **active** set-up.

3. Press **S1** to select mg/m^3.

4. Select metres as the unit of length, °C as the temperature unit, and kPa as the pressure unit by using a procedure similar to that described in the previous steps.

After the pressure unit has been selected the following text appears on the display:



There are more than three humidity units to choose from therefore the means by which a unit is selected differs:

5. Press ↵.

6. Use ▲ & ▼ to scroll through the options.

7. When Tdew is displayed, press ↵.

The display automatically returns to the head of the **CONFIGURATION** setup branch.

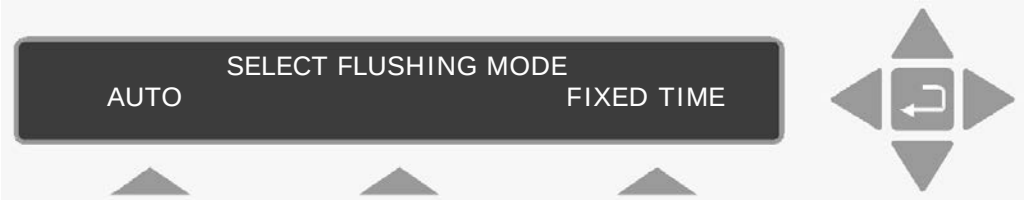
8. Press **SET-UP** to exit.

4.3.3 Setting the Environment Parameters

Environmental parameters describe the factors which influence the measurement situation – the length of the sampling tube attached to the Monitor and the normalization temperature. These parameters are discussed more fully later on in this section.

1. Press **SET-UP**, **S1** and then **S3**.

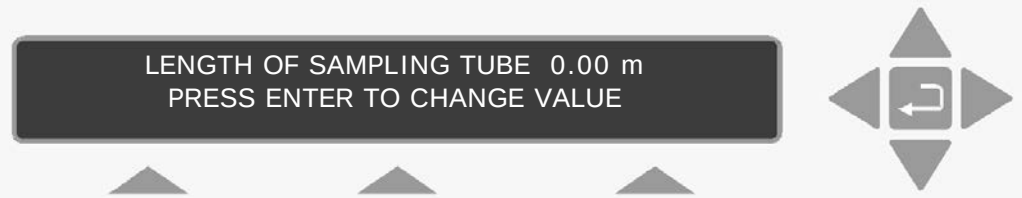
This brings you into the **Environment** branch of the Set-Up Tree where the following text is displayed:



The Auto option regulates the flushing time depending on the sampling tube length and the cleanliness of the air-filter (as the filter become dirtier, the flushing time will increase). The Fixed Time option is divided in to two parts; chamber flushing time and sample tube flushing time. Once defined, these times are constant regardless of the sampling tube length and cleanliness of the filters.

Auto Option

a. Press **S1**, and the following display appears.

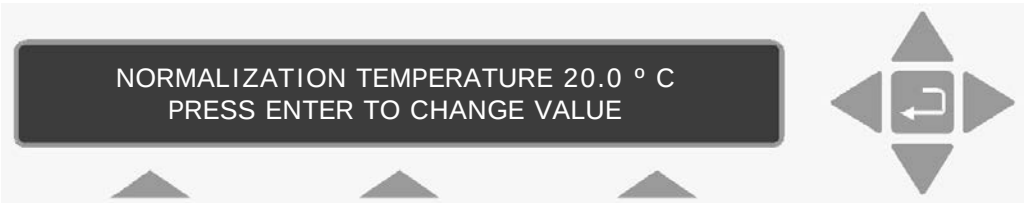


b. Press ↵.

c. Use the direction keys to define the tube length: ▲ and ▼ to increase and decrease the numbers, respectively; ◄ and ► to move the cursor across the fields.
Change the length of the sampling tube shown on the screen to the length of the tube you attached to the Monitor in section 4.2.
Note: the range of acceptable values for the sampling tube ranges from 00.00m to 99.00m.

d. Press ↵ to select displayed length.

The following display appears:



The Monitor measures gas concentrations in the absolute unit of mg/m^3 – a unit which is **dependent** on temperature. Alternatively, the Monitor can calculate gas concentrations in parts per million (ppm) by volume – this unit is **independent** of the temperature of the gas. If mg/m^3 is chosen as the gas concentration unit it is therefore necessary to define the temperature at which you wish the Monitor to calculate gas concentrations. This pre-defined temperature is termed the **NORMALIZATION TEMPERATURE**.

e. Press ↵ to change value.

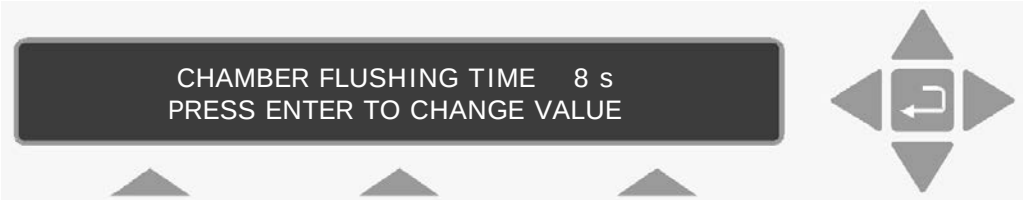
f. Use the direction keys to define the normalization temperature: ▲ and ▼ to increase and decrease the numbers, respectively; ◀ and ▶ to move the cursor across the fields.

g. Press ↵ to select displayed temperature.

The display screen then jumps to the "head" of the **MEASUREMENT** branch of the Set-Up Tree and the following text is shown:

Fixed Time Option

a. Press **S3**, and the screen displays the following text.



b. Press ↵.

c. Use the direction keys to define the chamber flushing time.
Note: the range of acceptable values for chamber flushing ranges from 2s to 60s, increasing in 1s intervals.

d. Press ↵ to select displayed flushing time, and the following text is displayed.

e. Press **S3** to enable sample tube flushing. The screen displays the following text.

f. Press ↵.

g. Use the direction keys to define the tube flushing time.
Note: the range of acceptable values for tube flushing ranges from 3s to 120s, increasing in 1s steps.

h. Press ↵ to select displayed flushing time.

The following text is displayed.

i. Press **SET-UP**

4.3.4 Setting up a Monitoring Task

The optical filter in the monitor has to be calibrated before it can be used to measure gas concentrations. The user can only set-up a monitoring task using the optical filters which has been installed. In the 3436i gas A (that is, to measure gas A's concentration using the UA0936 optical filter installed in position "A" of the filter carousel) and water vapour.
The parameters which describe the monitoring task we shall set-up, are listed below:

Stand-alone Settings

Monitoring Task Set-up Number = **1**

Sampling = **Continuous**

Monitor for pre-set period = **No**

Compensate for Water Vapour Interference = **Yes**

Compensate for cross-interference = **No**

Measure Gas A: XXXXXX = **Yes**

Measure Water Vapour = **Yes**

***Note**: flushing is set in Environmental Parameters, section 4.3.3, and the S.I.T's are set up in the Filters setup, section 12.3.3*

1. Press **SET-UP**, **S1** and then **S1**.

This brings you into the **Monitoring Task** branch of the Set-Up Tree where the following text is displayed:

Up to 10 different monitoring tasks can be set-up while operating the Monitor in **Set-up** mode. The parameters describing these tasks are automatically stored in the memory of the Monitor.

2. If the number on the display is already "1" then press ▼ to "accept" the value.

If the number is not "1":

a. Press ↵ and use the direction keys to change its value to "1".

b. Press ↵ to accept the value.

The text which appears on the display during the next step is really self-explanatory and it is therefore possible for you to follow why the

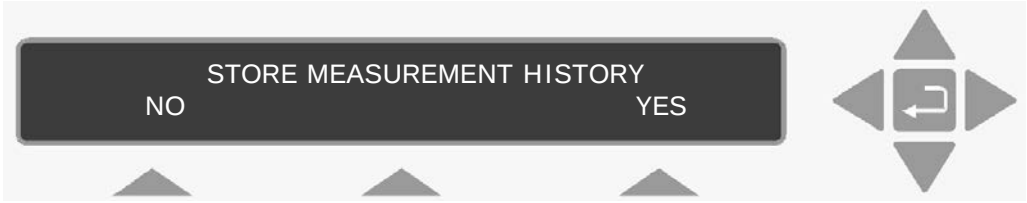
button-pushes listed in the next step will set-up the monitoring task which is described at the beginning of section 4.3.4.

3. Press **S3** **S1** **S3** **S1** **S3**, then press **S1** until the text **MEASURE WATER** **VAPOUR** appears on the display.

4. Press the **S3** button to answer “YES” to measure water vapour.

4.3.5 Store Measurement History.

The following screen is displayed.



a. If you select to answer No, then only the last measured values are stored in the display memory.

b. If you select to answer Yes all measured values are stored in display memory.

5. Press the **S3** button to answer “YES” to store the measurement history.

Once this step is complete, monitoring task number 1 has been set-up and the display moves to the previous head of the Set-Up Tree.

6. Press **SET-UP** to exit the **Set-Up** mode.

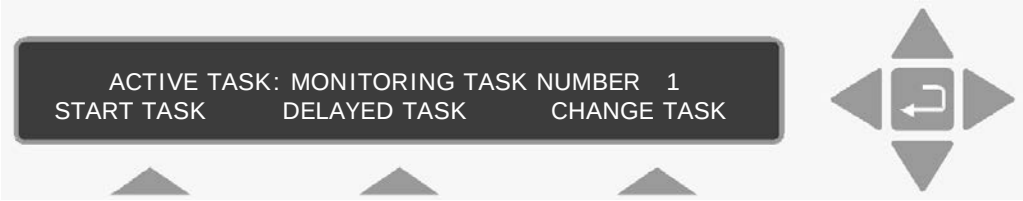
4.3.6 Starting a Monitoring Task

Note: before a monitoring task can be started, the Measurement Units, Environment Parameters and Monitoring Task Settings must be defined, see sections 4.3.2, 4.3.3 and 4.3.4.

This section will explain how to perform a monitoring task – for example, monitoring task number 1 which was set-up in section 4.3.4.

1. Press **MEASURE**.

The following text appears on the screen:



Please note: if you do not use one of the "select" keys within a short time after the above text appears, the Monitor will automatically stop operating in **Measure** mode (the light-emitting diode in the **MEASURE** key switches off).
If this happens just press **MEASURE** again.

The active monitoring task number is the number of the monitoring task you wish the Monitor to perform.

2. If the number on the display **is** number 1 then go to step 5.
   If the number on the display is **not** number 1 then press **S3** to change the task number to number 1.

This changes the display text to the following:

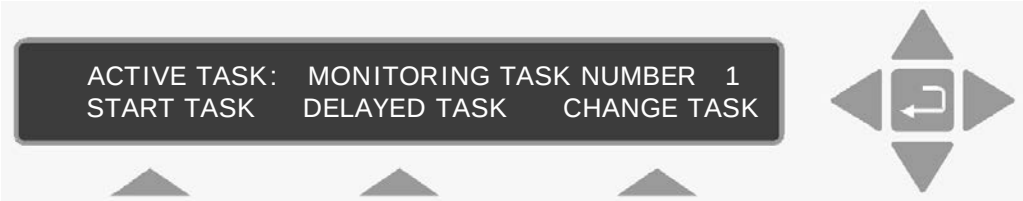
3. Press **S1**.

This causes the following text to appear on the display:

The number appearing on the screen will be a number from 1 to 10.

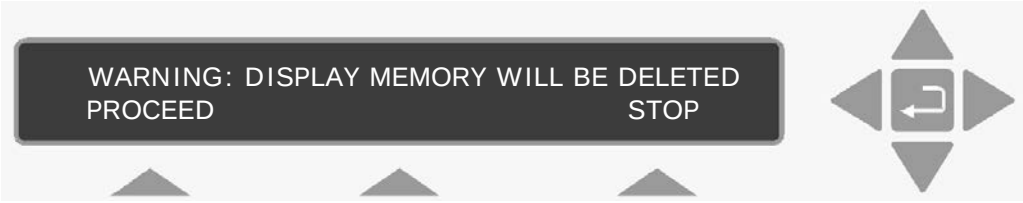
4. Press ↵ and use the direction keys to change the monitoring task number to 1.
   Then press ↵ again to accept the task number.

The following text appears on the display screen:



5. Press **S1** to start the monitoring task.

The following warning then appears on the display:



Display Memory is where the Monitor stores the results of all measurements while it is performing a monitoring task. If the monitoring task is stopped and then started again all the data already collected will be deleted from Display Memory. However, the data in *Display Memory* can be copied into and stored in the Monitor's *Background Memory*. This operation is described in section 9.2.

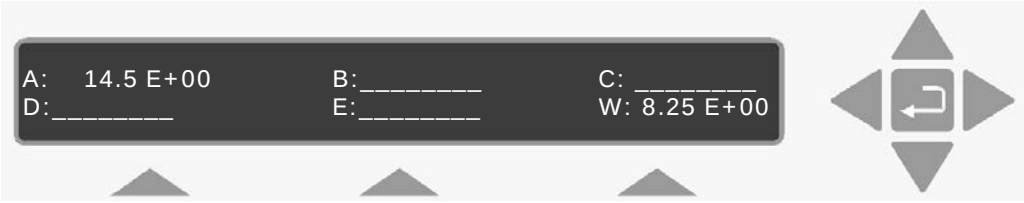
6. Press **S1**.

The following text then appears on the screen:

MEASUREMENT IN PROGRESS
RESULTS NOT YET AVAILABLE

7. When the first measurement cycle is complete the Monitor will automatically display the results and update them every time a new measurement cycle is completed. An example is shown below:

This display gives the overview of the gas/vapour concentrations last



measured – in this case the concentration of gas A and humidity of the water vapour are in the units that were selected – that is mg/m^3 for gas A and Tdew for water vapour (see section 4.3.2).

4.3.7 Displaying Measurement Results while a Monitoring Task is in Progress

If store measurement history is selected in the MEASUREMENT set-up branch (see section 4.3.5) all measurement data collected during a monitoring task is stored in Display Memory together with the parameters which describe the task (see section 4.3.4).

Using the direction keys, you can scroll through this data.

1. After the monitoring task has been running for 10-15 minutes, press ▼.

An example of the text which appears on the screen is shown below:

DATA IN DISPLAY MEMORY RECORDED FROM 2014-01-16 09:50 TO 2014-01-16 10:04

This screen text allows you to find out how long the monitoring task has been running here from 9:50 to 10:04 on the same day. The date on the right-hand side of the display indicates the time at which the last measurement cycle was completed while a monitoring task is in progress this date is, of course, constantly updated.

2. Press ▼ and then use ◄ & ► until the following text appears on the display:

FILTER A USED TO MEASURE (the name of the gas will appear here)

The displays which follow indicate the type of text which appears each time ▼ is pressed:

GAS A:	MAX 14.5E+00	μ 8.03+00
ALARM 1_____	MIN 7.42E+00	σ 2.36E+00

While a monitoring task is being performed a running statistical analysis of the monitored gases/vapours is made and the results are displayed as shown above, where:

MAX = maximum concentration of gas A measured during the period of time the monitoring task has been performed.

MIN = minimum concentration of gas A measured during the period of time the monitoring task has been performed.

ALARM 1 = the user-defined concentration of gas A which, if measured by the Monitor, will trigger a switch in the Monitor and activate an external alarm relay connected to it.

μ = linear average, or mean value, of all the gas A concentrations measured during the period of time the monitoring task has been performed

σ = standard deviation of gas A's concentrations from the mean value (μ) described above (see section 8.1 for further details).

All numbers are written in the exponential form, for example:

$$14.5E+00 = 14.5 \times 10^{+0} = 14.5$$

The concentration unit in this case is mg/m3 as this was chosen in the **active** set-up (see section 4.3.2).

3. Press ▼.

A: Sulphur Hexafluoride	**972.06 mBar**
2014-01-16 09:50:32 _____	**7.42 mg/m3**

A : Sulphur Hexafluoride	**972.06 mBar**
2014-01-16 09:51:33 _____	**7.42 mg/m3**

As you can see, the display provides the date and time at which the measurement was made, and the concentration of gas A is given in the units mg/m^3 because this was the unit chosen for gas concentration in the **active** set-up. The dashed lines, which appear after the time will be replaced by a number as soon as the monitoring task has been stopped (see section 4.3.8).

After scrolling through the list of individual measurement results for gas A, the following text is displayed:

SAMPLING IS CONTINUOUS

MONITORING PERIOD IS NOT PRE-SET

COMPENSATION FOR WATER VAP. INTERFERENCE

MONITORING TASK STARTED 2011-01-16 09:50

MEASUREMENT CHAMBER TEMPERATURE 29.6°C

SAMPLE INTEGRATION TIME W: 5s **A: 5s B:___s C:___s D:___s E:___s**

A:Sulphur hexaflouride B:_____ C:_____ **D: _____ E:_____ W: WATER VAP**

A: 7.42E+00 B: _____ C:_____ **D: _____ E: _____ W: 8.13+00**

The last display above shows the up-dated overview of the gas concentrations measured during the most recent measurement cycle. This display does not appear, after the monitoring task has been stopped.

Data collected during a monitoring task is stored in the *Display Memory* of the Monitor and therefore, before a new monitoring task is started, all data stored in this memory is deleted. *Display Memory* has finite size, and therefore there is a limit to how much data can be stored in it. Once this memory has been filled-up all subsequent data collected during the task will start to overwrite the data already collected during the start of the monitoring task. **Only** in this event will the date displayed after the text **MONITORING TASK STARTED** on the above screen be different from the **earliest** date on the display (shown below) which give the most up-to-date overview of the monitoring task:

DATA IN DISPLAY MEMORY RECORDED FROM **2014-01-16 09:50 TO 2011-01-16 10:04**

4. Press ▶.
This causes the following text to appear on the screen:

WATER VAPOUR MEASURED

Use ▼ to scroll through the following screen displays:

MONITORING PERIOD IS NOT PRE-SET

WATER: MAX 8.55E+00 μ 8.15+00 **MIN 7.01E+00 σ 816E-03**

```
W: WATER VAPOUR:                    971.88mBar
2014-01-16    09:50:32 _________    7.39Tdew
```

```
W: WATER VAPOUR:                    971.88mBar
2014-01-16    09:51:33 ________     7.49Tdew
```

5. Press ▶.

This causes the display to jump over to the list of measurement results for gas A. The following text appears:

```
A: Sulphur hexafluoride                 972.06 mBar
2014-01-16    09:51:33 __________       7.43 mg/m3
```

By using ▲ and ▼ you can now scroll through the list of measurement results for gas A.

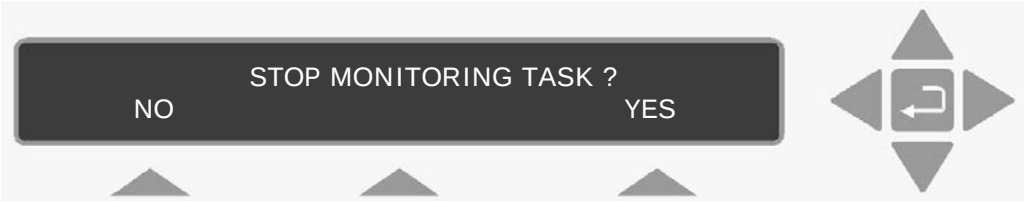
If you do not wish to view the results anymore, press ↵, this acts as a “go to head” function. The following text appears:

```
A: 7.42E+00     B:__________    C:___________
D: _________    E:__________    W:     8.13+00
```

4.3.8 Stopping a Monitoring Task

1. Let the Monitor, monitor for a total period of about 30 minutes and then press **MEASURE**.

The following text will appear on the screen:



If you pressed **MEASURE** accidentally, this screen enables you to cancel the request to stop the monitoring task in progress – by pressing **S1**.

2. Press **S3** to stop the task.

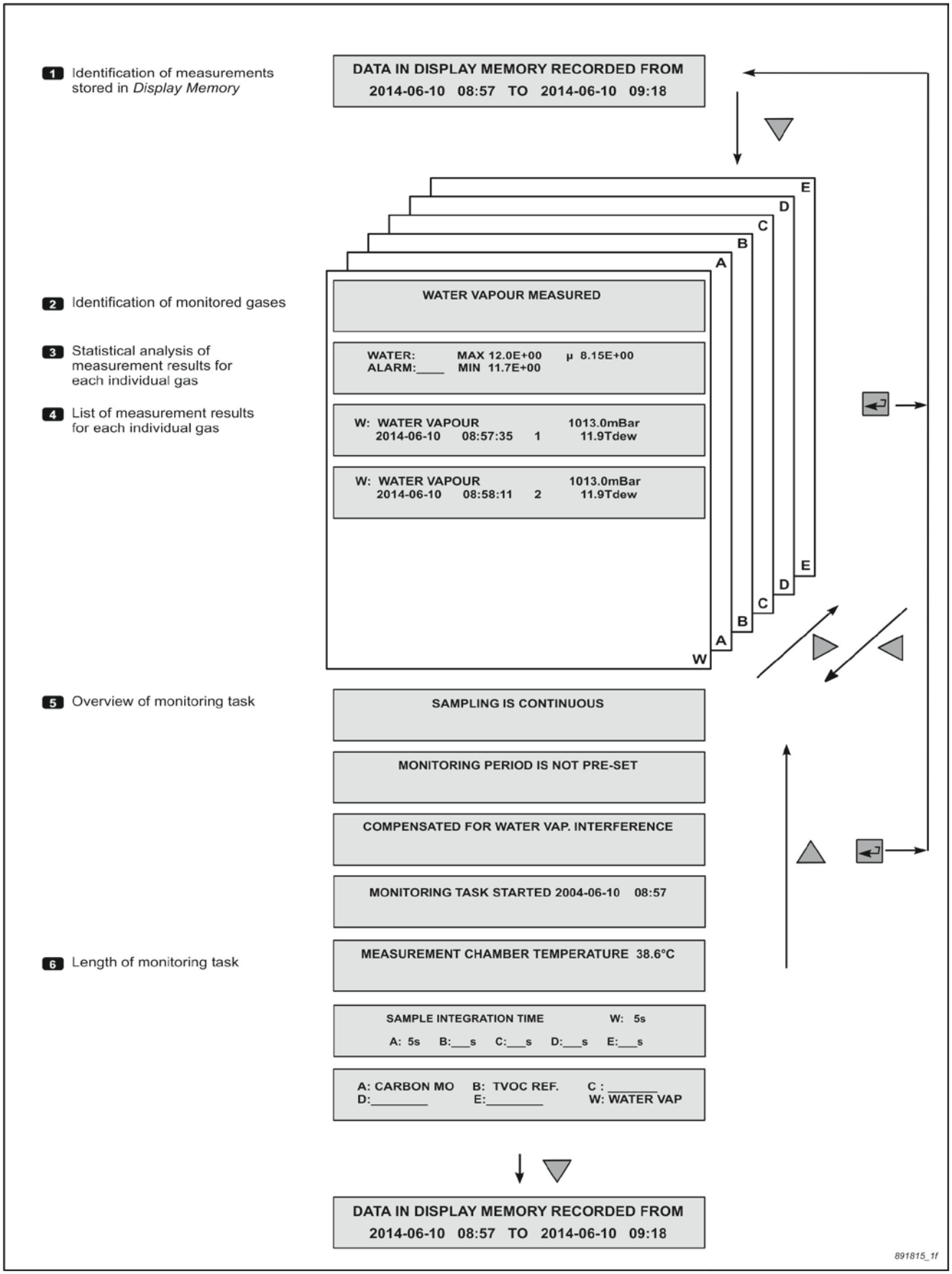
The text, which appears briefly on the screen, indicates that the Monitor is aborting the monitoring task and a summary of the monitoring task will appear on the display as soon as the Monitor has aborted the task. For example:

DATA IN DISPLAY MEMORY RECORDED FROM 2014-01-16 09:50 TO 2014-01-16 10:04

4.3.9 Scrolling through Measurement Results after Completion of a Monitoring Task

All measurement data collected during a monitoring task, is stored in Display Memory together with the parameters which describe the task (a description of the task is given in section 4.3.4).
Using the direction push-buttons, you can scroll through the set-up parameters as well as the individual gas concentration measurements results as explained in section 4.3.7. The organisation of data collected during a monitoring task is illustrated in Fig. 4.4. This illustration also shows the function of the various direction keys. For example, ▶ enables you to move from the measurement results of one gas to the measurement results of another.

Fig.4.4 Organisation of the data displayed on the Monitors screen after completion of a monitoring task :


1 Identification of measurements stored in Display Memory
DATA IN DISPLAY MEMORY RECORDED FROM
2014-06-10 08:57 TO 2014-06-10 09:18
2 Identification of monitored gases
3 Statistical analysis of measurement results for each individual gas
4 List of measurement results for each individual gas
WATER VAPOUR MEASURED
WATER: MAX 12.0E+00 μ 8.15E+00
ALARM:___ MIN 11.7E+00
W: WATER VAPOUR 1013.0mBar
2014-06-10 08:57:35 1 11.9Tdew
W: WATER VAPOUR 1013.0mBar
2014-06-10 08:58:11 2 11.9Tdew
A
B
C
D
E
W
5 Overview of monitoring task
SAMPLING IS CONTINUOUS
MONITORING PERIOD IS NOT PRE-SET
COMPENSATED FOR WATER VAP. INTERFERENCE
MONITORING TASK STARTED 2004-06-10 08:57
6 Length of monitoring task
MEASUREMENT CHAMBER TEMPERATURE 38.6°C
SAMPLE INTEGRATION TIME W: 5s
A: 5s B:___s C:___s D:___s E:___s
A: CARBON MO B: TVOC REF. C : _____
D:_____ E:_____ W: WATER VAP
DATA IN DISPLAY MEMORY RECORDED FROM
2014-06-10 08:57 TO 2014-06-10 09:18
891815_1f

1. Press ▼ and ▶.

The following text appears on the display:

WATER VAPOUR MEASURED

The displays which follow indicate the type of text which appears each time ▼ is pressed:

WATER:	**MAX 8.55E+00**	**μ 8.15+00**
ALARM 1	**MIN 7.01E+00**	**σ 816E-03**

This is the statistical report of the monitored gases/vapours displayed when the monitoring task is complete. In this case where:

MAX = maximum concentration of water vapour measured during the **whole** monitoring task.

MIN = minimum concentration of water measured during the **whole** monitoring task.

ALARM 1 = the user-defined concentration of water vapour which, if measured by the Monitor, will trigger a switch in the Monitor and activate an external alarm relay connected to it.

μ = linear average, or mean value, of all the water vapour concentrations measured during the **whole** monitoring task.

σ = standard deviation of water-vapour's concentrations from the mean value (μ) described above (see section 8.2.1 for further details).

The humidity unit in this case is Tdew because this is the unit chosen in the **active** set-up (see section 4.3.2).

W: WATER VAPOUR:			**971.88mBar**
2014-01-16	**09:50:32**	**1**	**7.49Tdew**

W: WATER VAPOUR:			**971.88mBar**
2014-01-16	**09:51:33**	**2**	**7.49Tdew**

As you can see the measurement cycles are numbered sequentially as soon as the monitoring task has been stopped for example, the above measurement was made at 09:51:33 on the 16th of January and it was the **second** measurement cycle of the monitoring task. The concentration of water vapour is given in the units of Tdew because this was the unit chosen for humidity in the **active** set-up.

After scrolling through the list of individual measurement results for water vapour the following screen displays appear:

SAMPLING IS CONTINUOUS

MONITORING PERIOD IS NOT PRE-SET

COMPENSATION FOR WATER VAP. INTERFERENCE

MONITORING TASK STARTED 2014-01-16 09:50

MEASUREMENT CHAMBER TEMPERATURE 39.6°C

SAMPLE INTEGRATION TIME W: 5s A: 5s B:___s C:___s D:___s E:___s

A: Sulphur hexafluoride B:_____ C:_____ D: _____ E:_____ W: WATER VAP

DATA IN DISPLAY MEMORY RECORDED FROM 2014-01-16 09:50 TO 2014-01-16 10:04

Note that the screen showing the overview of gas concentrations measured during any particular measurement cycle is no longer shown when the monitoring task has been stopped.

2. Press ▶.

This causes the following text to appear on the screen:

FILTER A USED TO MEASURE Sulphur hexafluoride

3. Press ▼ to scroll through the following data displays:

GAS A: MAX 14.5E+00 μ 8.03+00 ALARM 1_____ MIN 7.42E+00 σ 2.36E+00

A: Sulphur hexafluoride	**972.06 mBar**
2014-01-16 09:50:32 _____	**7.42 mg/m3**

A:Sulphur hexafluoride	**972.06 mBar**
2014-01-16 09:51:33 _____	**7.43 mg/m3**

Press ▶ so you can scroll through the list showing water-vapour's results.
If you do not wish to view the results anymore, press ↵, this acts as a "go to head" function.

4.3.10 Changing Gas-concentration Units after a Monitoring Task

The unit mg/m^3 was chosen for gas concentrations in the monitoring task, which was set up in section 4.3.4. As long as mg/m^3 is the **active** concentration unit (that is, the unit selected while operating in Set-Up mode), this is the unit which will be used to express gas concentrations on the display screens of the PC and the Monitor. It is also the unit when print-outs of monitoring task data are made from the Monitor. However, the user can express the measured gas concentrations in ppm:

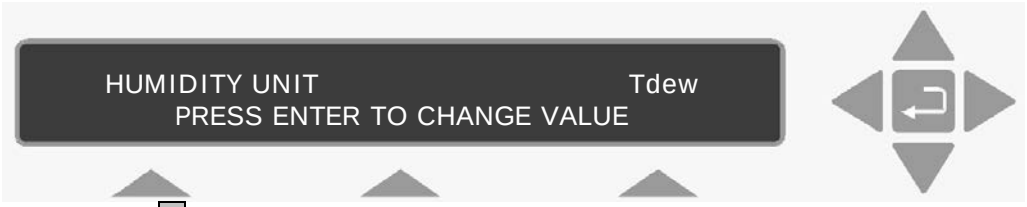
1. Press **SET-UP** **S3** **S2** **S3** and then **SET-UP**.

2. Use ▼ to scroll through the results of the monitoring task no. 1 displayed on the screen. Notice that the gas concentration units have been changed to ppm.

In a similar way the humidity unit for water vapour and the pressure unit can be changed.

4.3.11 Changing the Humidity Unit after a Monitoring Task

1. Press **SET-UP** **S3** **S2** and then ▼ to reach the following display:



2. Press ↵ and use the direction keys to display ppm.

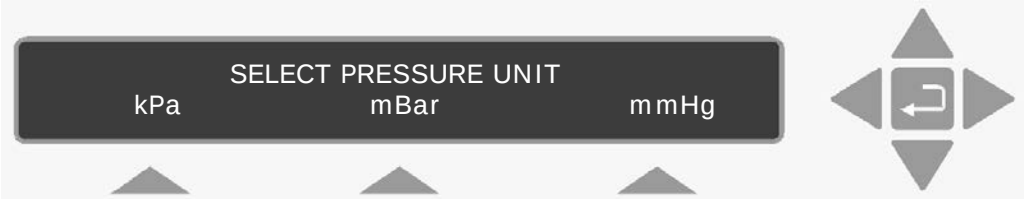
3. Press ↵ to accept the unit of ppm.

4. Press **SET-UP**.

Use ▼ to scroll through the results of the monitoring task no. 1 displayed on the screen. Notice that the water vapour unit has been changed to **ppm**.

4.3.12 Changing the Pressure Unit after a Monitoring Task

1. Press **SET-UP** **S3** **S2** and then ▼ to reach the following display:



2. Press **S3** to accept the unit of mmHg.

3. Press **SET-UP**.

Use ▼ to scroll through the results of the monitoring task no. 1 displayed on the screen. Notice that the Pressure unit has been changed to mmHg.

Chapter 5

The Monitor

April 2015

5.1 Introduction

This chapter is primarily for those users who want to use the monitor as a stand-alone instrument. But the start-up and alarm relay sections are also of interest for the PC user.

5.2 Front Panel

The front panel of the monitor is dominated by a 2 x 40 character fluorescent display screen, 3 **Select** push-buttons located beneath it and 5 **direction** push-buttons (see Fig. 5.1). The rest of the push-buttons, situated in a line along the bottom, are **function** push-buttons.

Small light-emitting diodes (LEDs) are mounted above some of the front-panel push-buttons. Their function is to inform you of the operating state of the monitor. For example, if the LED above the **MEASURE** push-button is lit, it indicates that the Monitor is either busy performing measurements or has been set-up to start measurements at a pre-defined time.

Fig.5.1 The front panel of the 3436i.

5.2.1 Direction Push-buttons

This group of 5 push-buttons is referred to in this manual as the direction push-buttons.

▲ & ▼ have two uses: to increase & decrease numbers, respectively, or to go to the Previous & Next Displays, respectively.

The number increase and decrease functions are used whenever values, which can be changed manually, are displayed on screen, for example, changing a parameter such as the length of sampling tube.

The “Previous Display” and “Next Display” functions are used when you want to view the previous or next screen texts. This can be useful when setting up the monitor. By using these push-buttons, you can scroll quickly through a branch of the Set-Up Tree. These push-buttons can also be useful when viewing measurement data, for example, if you are looking at gas A’s measurement result no.3 – by pressing ▲, gas A’s measurement result no.2 will be shown on the screen. By pressing ▼, gas A’s measurement result no.4 will appear on the display screen.

◄ & ► enable you to move across number fields or go to the Previous & Next gases, respectively.

When you are entering values or names in the monitor, for example when setting up the monitor, you can use these push-buttons to move the cursor across the entry fields.

“Previous Gas” & “Next Gas” functions are used primarily when viewing measurement data. The display screen only displays the measurement data for one gas at a time. These push-buttons allow you to look at the measurement data for the gas and water vapour (see Fig.4.4 and section 4.3.9).

↵ Depending on the situation, this push-button acts as either an “Enter” or “Go To Top of Measurements” function.

The “Enter” function is used whenever measurement units are selected or any text, for example filter names or gas names, are being entered. The Monitor display will typically display a text similar to PRESS ENTER TO CHANGE VALUE.

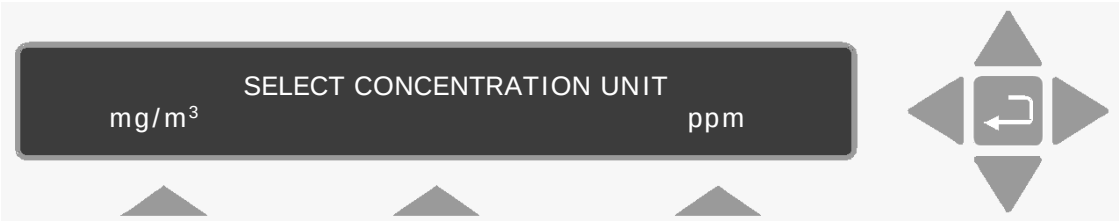
The “Go To Top of Measurements” function is used in the following situations:

- If you are viewing measurement data, when ↵ is pressed, the display will move to the screen showing the text DATA IN DISPLAY MEMORY RECORDED FROM... which gives the period of time data was recorded – see Fig.4.4 for details.
- If the Monitor is performing measurements when ↵ is pressed, the Monitor will display the last measured concentrations of all the gases.

5.2.2 The Select Push-buttons

Located below the text display screen, these three push-buttons, allow you to select from the pre-defined options appearing on the display screen. The following example illustrates the use of the select push-buttons:

If the text on the screen appeared as follows:



a. By pressing **S1** the gas concentrations which appear in the measurement results will be quoted in mg/m^3.

b. By pressing **S3** the gas concentrations which appear in the measurement results will be quoted in ppm.

5.2.3 Function Push-buttons

The order of these push-buttons are the same as they are seen on the front of the monitor.

RESET By pressing this push-button you can choose the type of reset the Monitor should perform. For further details see section 5.3.

LOCK This push button enables setting up three different password protected User Levels. For further details see section 2.6.

MEASURE In this mode you are able to choose the type of measurement the Monitor should perform, and decide when the measurement should start.

AVERAGE This push-button allows you to average measurement data. The lamp in this push-button is lit when measurement data is being averaged. You define the averaging times using the set-up **mode**.

EVENT (If an unusual or interesting event occurs during a measurement period, you can mark the time such an event took place by pressing this push-button. Each event marker is given a serial number, which can be used as a reference. Events are marked on print-outs of measurement data.

MEMORY In this mode you are able to store measurement data in the *Background memory* of the monitor, as well as recall or delete data from the *Background memory*.

INFO This push-button has two functions. It allows you to perform the following two functions:

- Acknowledge any message, which may appear on the display screen during operation of the Monitor.
- Obtain more detailed information about the condition of the Monitor at any particular moment of time, if such information exists.

PRINT By pressing this push-button, measurement results in the *Display memory* of the Monitor can be printed out. The lamp above this push-button is lit, while measurements are being printed and the display will show PRINTING MEASUREMENT DATA until all data has been printed out.

SET-UP In this mode you are able to enter the Set-Up Tree of the Monitor. In set-up **mode,** the user is able to program the Monitor to perform almost any kind of measurement, and amongst other things; enter data about the optical filter(s) which are installed in the Monitor; select different measurement parameters; choose how measurement results should be formatted in print-outs; choose the interface and communication codes which are necessary to print data; set the internal clock of the Monitor and choose the self-tests the Monitor should perform.

When the **Talk/Listen** LED is lit, this means that there is activity on one of the interfaces.

5.3 Starting-up or Restarting the Monitor

5.3.1 Introduction

When the monitor is started up in the normal way, that is, by switching on the AC Mains power-switch on the back panel, the monitor responds by performing a **partial reset**. A **partial reset** is also performed if during operation the monitor is switched off and is re-started in any of the following ways:

- If the Monitor stops operating due to an AC mains power failure and then re-starts itself (automatically) when power is restored to it;
- If the user stops operating the Monitor by switching it off using the AC mains power switch on the back panel, and then re-starts it by using the same switch:

Users can also "partially reset" the Monitor by using the **RESET** push-button on the front panel (see section 5.2.3).

5.3.2 A Partial Reset of the Monitor

When the Monitor performs a **partial reset** a number of self-tests are automatically performed. The types of tests performed depend only upon the time, which has elapsed since the Monitor was last switched on.

- If **more** than 10 mins. have elapsed since the Monitor was switched on it will perform the **software**, **data-integrity**, and **hardware** tests when switched on again.
- If **less** than 10 mins. have elapsed since the Monitor was switched on it will perform only the **data-integrity** tests when switched on again.

There are essentially 3 types of self-tests which can be performed during a "partial reset" – a **software** test, a **data-integrity** test and a **hardware** test.
It takes the Monitor only a few seconds to perform the **data-integrity** tests; and about 3 minutes to perform both the **software** and **hardware** test. The different tests are explained below.

Software test
This test checks the information in the Monitor's software (ROM – **R**ead **O**nly **M**emory.)

Data-integrity test
This test checks the integrity of the data stored in the Monitor's Source Memory (i.e. its EEPROM – **E**lectrically **E**rasable

Programmable **R**ead **O**nly **M**emory) and the integrity of the data stored in the Monitor's ***Working Memory*** (RAM).

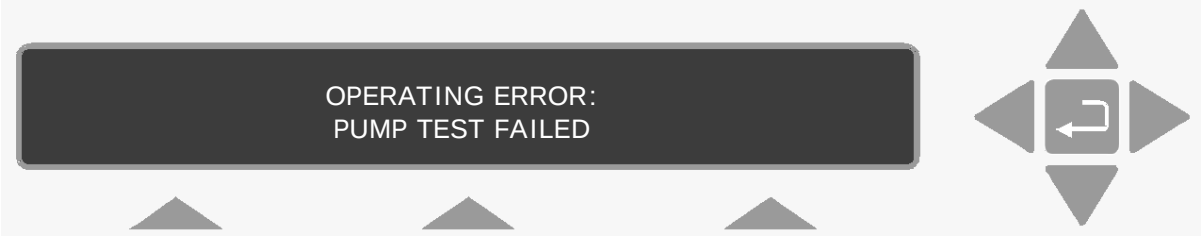
Hardware test

This test checks that the electrical, mechanical and electronic parts of the Monitor are functioning properly.

The following parts of the Monitor are checked: the pump; the valves in the pneumatic system; the infra-red light source; the power supply; the filter carousel; the motor which drives the chopper wheel; the external vibration level (to make sure that it does not contribute to the signal measured in the analysis cell); the analogue circuitry and the microphones (to check that they are functioning properly).

If you do not wish the Monitor to perform the **hardware** test during a partial reset, you can disable it (see section 5.4.3). This also disables the regular self-tests.

If any part of the Monitor is found to be functioning incorrectly a message will appear in the display to inform the user of the problem. For example:



The user must acknowledge receipt of such a message by pressing **INFO**. Operating errors and warning messages are listed in table-form in Chapter 14 at the end of this manual.

If a fault is found in any of the blocks of data stored in the ***Working Memory***, the Monitor will automatically set the parameters in the relevant compartment(s) to their default values, and the Monitor will send the following message on its display screen:

WARNING: MEMORY SET TO DEFAULT
ERROR DETECTED IN XXXXX MEMORY

Where XXXXX denotes the part of the memory that has been affected. When such a message is received users must check the contents of the relevant memory to find out which data has been affected before continuing to operate the Monitor.

5.3.3 Response of the Monitor after a Partial Reset

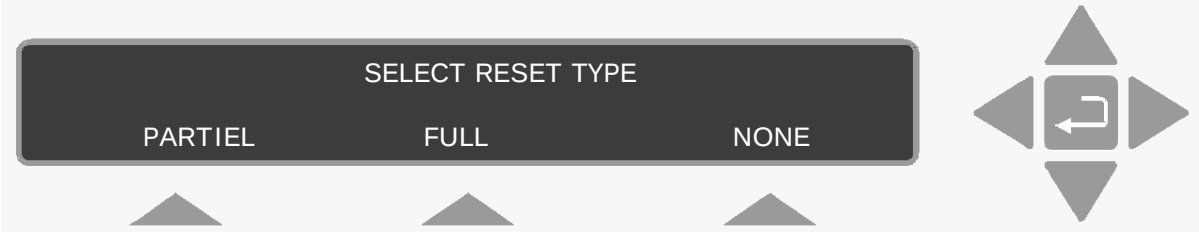
The way in which the Monitor responds after a **partial reset** is dependent upon the way it was being operated at the time of the partial reset (see Table 5.1). For example, if the Monitor was busy taking a measurement when it was "partially reset" it will complete the interrupted measurement after the partial reset, continue its monitoring task and make a special "mark" alongside the first complete measurement cycle it performs after the reset. These "marks" are described in section 8.2.2 and section 8.2.3.

Table 5.1 Dependence of Monitor's response, after a partial reset, to its operating condition at the time of the partial reset.

Monitor last used while in…	**Task being performed**	**Task started after a PARTIAL RESET**
Measurement **mode**	A gas measurement	Completes the monitoring task
"Display"	Looking at measurement results on the display screen	Measurement results are shown on the display from the beginning again
Set-up **mode**	Changing set-up parameters which control the operation of the Monitor	Measurement results are shown in the display from the beginning
Memory **mode**	Handling measurement results which are stored in Display Memory and Background Memory	Completes any interrupted task and then measurement results are shown in the display from the beginning
"Interface"	Obtaining hard-copies (that is, print-outs of, for example, measurement data)	Print-out is stopped and measurement results are shown in the display from the beginning

5.3.4 Full reset and/or Partial Reset of the Monitor via its Front Panel

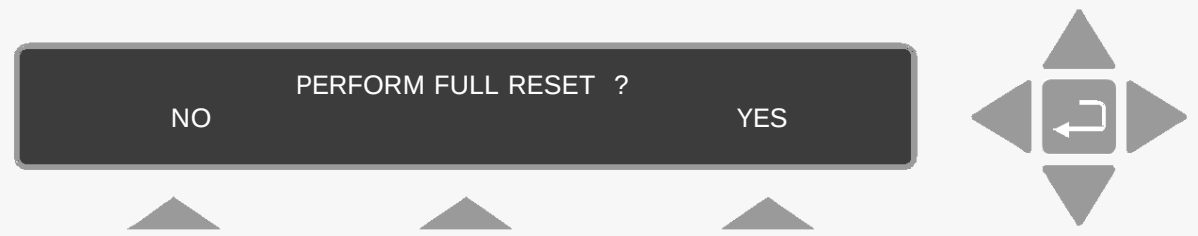
There are two well-defined levels of reset. By pressing **RESET** the following text appears on the display screen:



If **S3** is pressed, you can come out of reset mode without performing any kind of reset. The Monitor just goes back to operating the same way it was operating before the **RESET** push-button was pressed.

S1 **PARTIAL** Reset: If this level of reset is chosen the Monitor stops operating, performs a **partial reset** as described in the previous section (section 5.3.2) and then resumes operating in the fashion described in Table 5.1.

S2 **FULL** Reset: If this level of reset is chosen the Monitor responds by changing the text on the display so that you have a chance to **confirm** that you wish the Monitor to perform a **FULL** reset:



S1 By pressing this push-button the user can come out of reset **mode** without performing any kind of reset. The Monitor just goes back to operating the same way it was operating before **RESET** was pressed.

S3 By pressing this push-button the user confirms that a **FULL** reset is required. During a **FULL** reset the Monitor performs the following two tasks:

- "Clearing" (emptying) all data from its ***Working Memory***. This means all data in ***Display Memory*** and ***Background Memory*** will be lost.
- Copying data from its ***Source Memory*** into its ***Working Memory***. This means that set-up parameters in block 3 of ***Working Memory*** "Other Set-up Parameters" will be given their **default** values, and the values of the optical filter set-up parameters in ***Working Memory*** will be the same as those found in ***Source Memory***.

5.4 Configuring the Monitor

5.4.1 Setting the Clock

Before dispatch from the factory, the internal clock of the Monitor is set to the correct local (Danish) time.

The current date is entered as Year-Month-Day for example the 24th of July 2014 is entered as 2014-07-24.
The current time is entered as the time on the 24-hour clock for example 14:05 is five minutes after two in the afternoon. Table 5.2 details the range of acceptable values and the default value of the date and time.

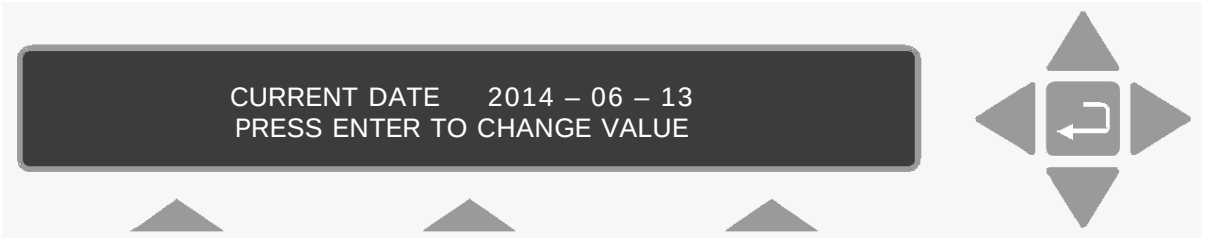
Table 5.2 The range of acceptable values and the default value of the date and time

Display Text	Acceptable Values	Default Value
ENTER CURRENT DATE 0000-01-01	0000-01-01 to 9999-12-31	2013-01-01
ENTER CURRENT TIME 12:47	00:00 to 23:59	12:00

If the Monitor is to be used as a stand-alone instrument, then the clock can be adjusted to your local time using the following instructions.

1. Press **SET-UP**.
   Refer to the Set-Up Tree diagram, so that you can follow your progress through the various branches of this set-up.

2. Press **S3** **S1** **S1** **S1**.
   The following screen picture appears:



3. To change the date, press ↵.

4. Use the direction push-buttons to enter the correct date. If you make a mistake, press **S1** to revert back to the original date.

5. Press ↵ to accept the date.
   This causes the text on the display screen to change to the following:

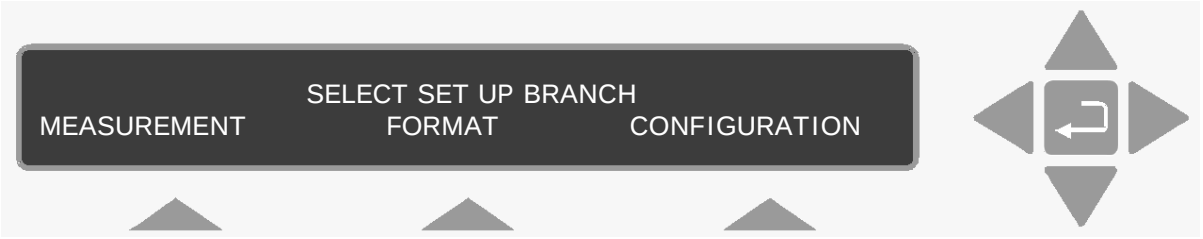
6. To change the time, press ↵.

7. Use the direction push-buttons to enter the correct time. If you make a mistake in entering the correct date just press **S1** and start again.

8. Press ↵ to accept the time.

When Step 8. has been completed the display then moves to the **previous** head of the set-up "tree".

9. Press ▲ three times. The screen display shows the following text:



10. Press SET-UP to exit the set-up function.

5.4.2 Adjusting the Sound Level

During certain operations or, for example, when an incorrect push-button is pressed, the Monitor emits a "beep". You choose the volume of the Monitor's "beep". The volume of the "beep" is expressed on a scale from 0 (no "beep") to 3 (loudest "beep"). Table 5.3 provides details of the available choices and the default value of this parameter.

Table 5.3 The available choices and the default value of the Monitor's "beep"

Display Text	Available Choices	Default Value
ENTER SOUND VOLUME 0	0, 1, 2, 3	1

To set the volume:

1. Press **SET-UP**.

2. Press **S3** **S1** **S1** **S2** .
   The following screen picture appears:

3. To change the volume, press ↵.

4. Use the direction push-buttons to enter the correct volume. If you make a mistake, press **S1** to revert back to the original volume.

5. Press ↵ to accept volume.

6. Press **SET-UP** to exit the set-up function.

5.4.3 Enabling / Disabling Self Tests

If you do not wish the Monitor to perform regular self-tests, including the **hardware** test on power-up you can disable it.

1. Press **SET-UP** **S3** **S1** **S1** **S3**

2. Press **S1**, the Monitor no longer performs the **hardware** test as part of its self-testing procedure during any kind of reset.

3. Press **SET-UP** to exit the set-up function.

5.5 Alarm Relay

Two alarm relays are built into the **alarm relay** socket on the back panel of the Monitor. The function of the pins in this female connector are shown in Fig.5.2. The two alarm relays can be connected to a variety of either audio (for example, a siren)

and/or visual (for example a flashing light) alarm systems and they are activated whenever a pre-defined concentration (alarm level) of one (or more) of the gases being measured is exceeded. Alarm signals are given by opening and closing the relay contacts.

Both relays are closed when the Monitor is switched off and when the Monitor is switched on. This means that there is a direct electrical connection between pins 1 & 2 and pins 4 & 5 at all times except when the Monitor measures a gas concentration which is greater than the corresponding alarm limit for the gas. When this concentration is measured, the Monitor breaks the connection between pins 1 & 2 or 4 & 5. The monitor will furthermore activate the internal beeper and write the following message on the display:

WARNING:
ALARM LIMIT EXCEEDED

The user can switch off the beeper and the message by pressing **INFO** or **RESET** push-button on the front-panel of the Monitor.
The alarm relays will continue being activated until either (1) **all** measured gas concentrations fall below their user-defined alarm level(s); or (2) the monitoring task is stopped – this automatically closes the alarm relays.

Alarm Relay 1:

Alarm Relay 1: correspond to High Alarm Limit 1.

Whenever one or more gases exceed their alarm level(s) for high alarm limit 1, the Monitor breaks the electrical connection between pins 1 & 2 and this activates the attached alarm system.

Alarm Relay 2:

Alarm Relay 2: correspond to High Alarm Limit 2.

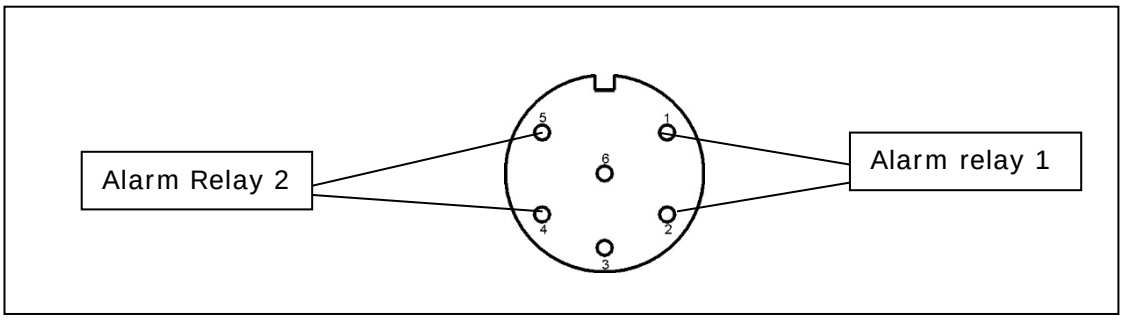
Whenever one or more gases exceed their alarm level(s) for high alarm limit 2, the Monitor breaks the electrical connection between pins 4 & 5 and this activates the attached alarm system.

LumaSense supplies a 6-pin DIN plug (male) with a locking collar JP0600 for connecting external alarm devices to the alarm relay.

Caution:
The DC voltage across the relay contacts must not exceed 25V. The potential on the relay contacts must not be more than 25VDC above chassis potential, as this will cause an excessive leakage current. The

current through the contacts must not exceed 100mA. AC voltages must not be connected to the Alarm Relay socket.

Fig.5.2 Configuration of the pins in the alarm relay socket



5.6 Continuous Warm System

The Continuous Warm System ensures that the monitor is kept warm at any time that is also when the Monitor is not measuring.

If the Monitor is powered up at all time you can save the warm up time when starting a measurement.

5.6.1 Setting-up the Monitor to Continuous Warm System

The procedure to enable the Continuous Warm System is as follows:

1. Press the following push-button sequence: **SET-UP** **S3** **S1** **S1**, and the following text is displayed:

SELECT GENERAL SET-UP BRANCH ?		
CLOCK	SOUND	TESTS

2. Press **S3** ▼ **three times** **S3** **SET-UP**. This selects the continuous warm system.

3. Press **RESET** **S1** (Partial Reset) in order to enable the continuous warm system.

Chapter 6

Keying-in Parameters

April 2015

6.1 Types of Parameters

There are four types of parameters:
Numerical: you are free to enter the desired values. However, there may in many instances be a range in which your values must lie. These ranges can be found in the relevant sections of this manual.
Text: you are able to type user-defined text, for example, the names of the gases you are measuring and when using the PC the names of your databases.
The characters available to you when using the monitor on its own are shown in the table below:

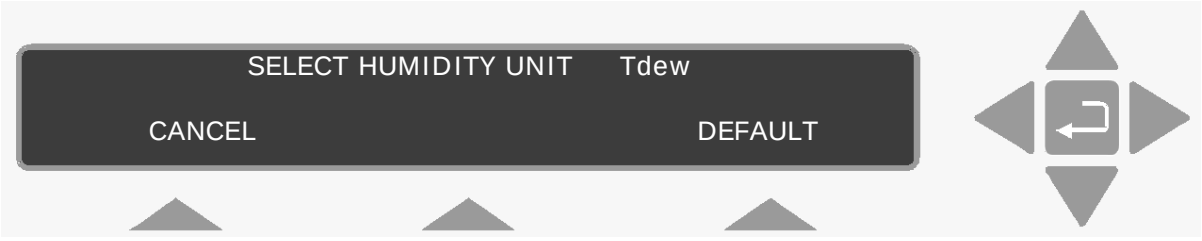
Fig.6.1 The characters which are available for gas names

Characters available for Gas Names
▲ → AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSs TtUuVvXxYyZz_' ". , : ; &!?@ | ^ # $ \ % / + - ( ) { } [ ] < > Ø 1 2 3 4 5 6 7 8 9 AaBbCc etc ←▼

Pre-defined: you are able to select a parameter using the "select" push-buttons when there are three or less options, or by scrolling through a pre-defined list using the direction push-keys. The parameters in the lists are given in more detail in the relevant sections of this manual.
Current Time: in the monitor is synchronized to match the time and date of the internal clock in the PC when the two are connected together. However, it is possible to adjust the monitors date and time using the front panel push-buttons. This is described in full in section 5.4.1.

Stand-alone Use

Whenever you are choosing parameters and/or "entering" parameter values via the front-panel push-keys, two options are available:



CANCEL This option appears over the **S1** select push-button. If you change the value of a parameter on the display screen and then decide that the new value is not correct, the original parameter can be brought back to the screen by pressing **S1**.

Default This option appears over the **S3** select push-button. If you wish the parameter appearing on the display screen to be the same as the factory-defined value you can press **S3**.

Some parameters do not have pre-defined **default** values, so that when **Default** is used a blank line will appear instead of a number. The **default** value of such a parameter is said to be "blank". For example:

GAS A'S HIGH ALARM LIMIT 1_____ppm
CANCEL DEFAULT

If the value of a chosen parameter lies outside the pre-defined minimum and maximum values the value will be corrected and, at the same time, a "*beep*" will sound. You will then have to "enter" the correct value by pressing ↵ and repeating the process.

When you have to choose or change a parameter, and the text **PRESS ENTER TO CHANGE VALUE** is displayed, use the direction push-buttons and follow the procedure below. Details about the direction keys are provided in section 5.2.

1. Press ↵. A cursor will *blink* under one of the parameter's numbers or letters and the bottom line will display the soft-keys **Cancel** and **Default**.

2. Use ▲ and ▼ to change the entry above the cursor to the desired number, letter. For pre-defined parameters, these push-buttons enable you to scroll through the list. Display the desired parameter, then go to step 5.

3. Use ◄ and ► to move the cursor across the entry fields and repeat step 2.

4. Repeat steps 2 and 3 until the entry fields show the desired value or text.

5. Press ↵.

If the parameter you desire is already selected (i.e. a cursor is displayed under it), then using ▼ enables you to move directly to the next display.

These procedures are common for all the parameters in the Monitor.

Chapter 7

Setting-up and Starting a Monitoring Task

April 2015

Before a measurement task can commence, there are a variety of parameters that *must* be defined first. This is called “Setting up the Monitor”.

This chapter instructs you on how to set up the monitoring system before starting to measure. As mentioned previously in this manual, the parameters can be defined using the PC Use instructions, i.e. when using a PC, or the stand-alone Use instructions, i.e. when using the front panel push-keys on the monitor.

Before leaving the factory, each of the parameters found in the set-up “tree” (see the Quick Set-up Guide) are given factory values (**default values**).

When setting-up the Monitor as a stand-alone instrument, those values with a cursor underneath them are the **active values**. It is the **active values,** which determine how the Monitor will operate.

Warning! Failure to define any parameter may result in the default parameters being used. This can result in the monitor measuring incorrectly or being unable to start the measurement task.

7.1 The Parameters’ Units

The Monitor works internally with measurement parameters in SI units. These units can be converted and displayed as a variety of other measurement units. Defining the units here has two uses. It enables you to set-up the measurement parameters using familiar units and displays the measurement results with the desired concentration units.

These parameters are listed below.

Table 7.1 The possible parameter units and the default settings

Parameters	Units	Default Unit
Humidity	mg/m^3, ppm, Tdew, kPa	mg/m^3
Pressure	mbar, mmHg, kPa	kPa
Temperature	°C, °F, K	°C
Gas Concentrations	mg/m^3, ppm	mg/m^3
Length	m, ft	m

The units for existing measurement results can also be changed using these instructions.

Normalization Temperature

If you have chosen to measure gas concentrations in the unit mg/m3, you must “enter” the temperature at which the Monitor should calculate gas concentrations. If, for example, you “enter” a normalization temperature of 25°C, the measured gas concentrations, which appear on the display during a monitoring task will be calculated in mg/m3 units at **25°C**. The acceptable values and the default values of the normalization temperature are given in Table 7.2 in the different temperature units.

Table 7.2 The acceptable values and the default values of the normalization temperature

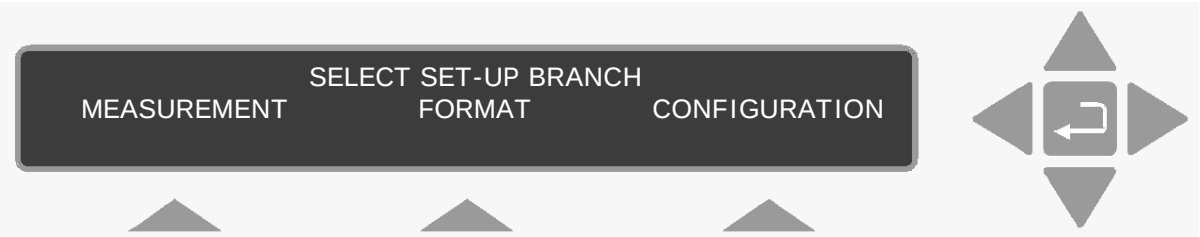
Display Text	Acceptable Values	Default Value
NORMALIZATION TEMPERATURE	0°C, 20°C and 25°C	20°C
NORMALIZATION TEMPERATURE	32°F, 68°F and 77°F	68°F
NORMALIZATION TEMPERATURE	273K, 293K and 298K	293K

7.1.1 Stand-alone Unit Set-up

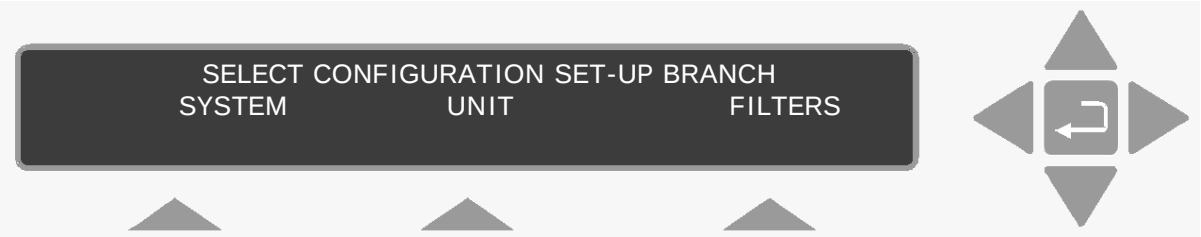
For those of you setting up the monitor using these instructions, it may be useful for you to follow the steps taken using the Set-Up Tree.

The philosophy of the instructions is described in section 3.2.

To enter at the top of the Set-Up Tree, press **SET-UP** and the monitor displays the following screen text.



1. Press **S3** to enter the **CONFIGURATION** branch. The new text displays three branches.



Units branch

2. Press **S2** to enter the **Units** branch.

3. Use the select push-buttons to define the concentration unit.

4. Use the select push-buttons to define the length unit.

5. Use the select push-buttons to define the temperature unit.

6. Use the select push-buttons to define the pressure unit.

7. The humidity unit is displayed. Use the direction push-buttons to change it to the correct value.

When step 7 is completed the display returns to the top of the **Units** branch.

Press ▲ to go to the top of the Set-Up Tree, or press **SET-UP** to exit the set-up mode.

7.2 The Measurement Parameters

Sampling:

Sampling mode: the manner in which the gases are sampled. There are two possibilities here:

Continuous sampling: once the monitor is finished measuring it starts again making the next measurement, for a full explanation see section 4.1.

Interval Sampling: this is the time from the start of one measurement cycle to the start of the next one, for a full explanation see section 4.1.

Table 7.3 The range of acceptable values and the default value for the Fixed interval sampling

Acceptable Values hours:minutes	Interval hours:minutes	Defalut Value hours:minutes
00:01 to 01:00	00:01	00:02

Flushing: the length of time the monitor flushes the measurement chamber and the sample tubing between measurements. There are two options here:

Auto: the monitoring system controls the flushing by selecting the optimum flushing time. This time can vary as this option takes into account the cleanliness of the external air-filters and the length of the sampling tube.

Therefore, the sample tube length must be defined.

Table 7.4 The acceptable values and the default values of the length of the sampling tube

Monitor Display Text	Acceptable Values	Default Value
LENGTH OF SAMPLING TUBE	0 – 99 metres	0.00
LENGTH OF SAMPLING TUBE	0 – 324.90 feet	0.00

Fixed Time: there are two selections here: Chamber, which is always selected with this option and Tube. See Table 7.5 for the acceptable values.

Table 7.5 The range of acceptable values and the default values for the chamber and sample tube flushing times

Acceptable Values	Interval	Default Value
Chamber: 2 to 60 s Tube: 0 (=off), 3 to 120 s	1 s 1 s	8 s 3 s

Water Interference: the Monitor is capable of measuring water's contribution to the signal measured in its analysis cell. The user can decide whether or not the signal should be compensated for water's contribution. It is suggested that water should be compensated for in all measuring situations except where extremely dry gases are being measure.

Gas Monitor Display / Averaging Period (3436i stand-alone use): this enables you to decide if instantaneous values or averaged values are displayed on the gas monitors screen.

If average values are desired, then the example below illustrates how the values are calculated and displayed.
Let us suppose that the Monitor has been taking measurements every 2.5 min., over a period of 30 min., of gas A Sulphur hexafluoride and the following results (un-shaded area) were obtained and recorded in the display memory, for stand-alone users.

A: Sulphur hexafluoride

					Averaged Values	
0	11:42:30	1	66.72	mg/m^3	66.72	mg/m^3
0	11:45:00	2	154.90	mg/m^3	110.9	mg/m^3
0	11:47:30	3	271.30	mg/m^3	164.3	mg/m^3
0	11:50:00	4	415.90	mg/m^3	227.2	mg/m^3
0	11:52:30	5	588.70	mg/m^3	299.5	mg/m^3
0	11:55:00	6	789.70	mg/m^3	444.1	mg/m^3
0	11:57:30	7	1.019	g/m^3	616.9	mg/m^3
0	12:00:00	8	1.276	g/m^3	817.9	mg/m^3
0	12:02:30	9	1.562	g/m^3	1.047	g/m^3
0	12:05:00	10	1.876	g/m^3	1.304	g/m^3
0	12:07:30	11	2.218	g/m^3	1.159	g/m^3
0	12:10:00	12	2.589	g/m^3	1.904	g/m^3

Let us suppose that the averaging period was set to 10 min. When the above measurement results are displayed on the screen and the averaging function is activated then each measurement will be averaged over the previous 10 min. and the averaged measurement results will replace the individual measurement results (averaged results are shown in the shaded area in the list above). For example: measurement number 7 would be 616.9 mg/m^3. This is the average of the 5 measurements taken in the 10 min. period ending at 11:57:30. Measurement number 12 would be 1.904 g/m^3 which is the average of the 5 measurements taken in the 10 min. period ending at 12:12:00.

The range of acceptable values and the default value of the averaging period are shown in Table 7.6.

Table 7.6 The range of acceptable values and the default value of the averaging period

Display Text	Acceptable Values	Default Value
ENTER AVERAGING PERIOD 00:10	**hours:minutes** 00:10 to 12:00	**hours:minutes** 00:10

Stand-alone Use

When the averaging function is active it will not only affect the results displayed on the screen but also the measurement results which are being printed out from *the Display Memory* (see Chapter 10). However, when the averaging function is deactivated – by pressing **AVERAGE** again (the LED will switch off) – the original results (un-shaded) will replace the averaged results on the screen.

Gas :

Gas Setup: there are up to six selections here: A,B, C, D, E and W. These represent the filter positions in the monitor's filter carousel. When setting up a new monitoring task, you can choose freely between the gases available for the filter (names entered when calibrating the filter, see sections 12.3 and 12.5). Once a gas has been selected for the filter and the measurement task started, you can no longer change the gas for this filter in this measurement task. However, you can still select gases for filters, which have not previously been used in the measurement task.

Note: only one gas per filter can be selected at a time for measuring. The W position always represents the water filter installed in the monitor.

Sample Integration Time: this enables you to make a choice between speed and accuracy. Generally, the longer the integration time the more accurate the results. There are several selection possibilities here:

Integration Type	Integration Time
Fast	1 s
Normal	5 s
Low Noise	20 s
Advanced	0.5s, 1s, 2s, 5s, 10s, 20s, 50s

Alarm set-up:

Select Gas: this option enables you to select any of the gases (one per filter position) already defined in the set-up.

Limit: enables you to define the gas concentration that will trigger the alarms. The acceptable values are shown in Table 7.7.

Select limits: this defines the concentration level when the alarm is triggered. This parameter must be defined.

Table 7.7 The range of acceptable values and default value of the alarm limit for the gases

Display Text	Acceptable Values	Default Value
GAS A HIGH ALARM LIMIT 1 n* _____PPM	0-1000000ppm	Blank
GAS A HIGH ALARM LIMIT 1 n* _____mg/m3	Depends on the molecular weight of the gas	Blank

n* = A to W

The Rolling Average option enables you to prevent the alarm being triggered by sudden, small fluctuation in the gas concentrations by using values, which are averaged over a defined period of time. The averaging time is defined in minutes. The acceptable values are: 1 to 999 mins, and the default value is 10 mins.

Action: this provides you with 3 ways to trigger the alarm. One or more of the options can be selected simultaneously.

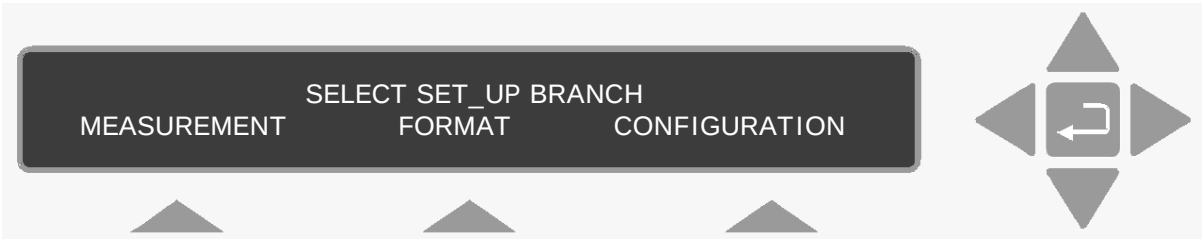
-Monitor Beep: when an alarm is triggered the monitor makes a beeping noise.
Monitor Relay 1 & Monitor Relay 2: selecting these options enable you to connect the alarms to a variety of either audio (for example, a siren) and/or visual (for example a flashing light) alarm systems.

Active Alarms: only the gases, which you have selected and activated, are shown in this field.

7.2.1 Measurement Set-up – Stand-alone Use

The philosophy of the instructions is described in Chapter 3.

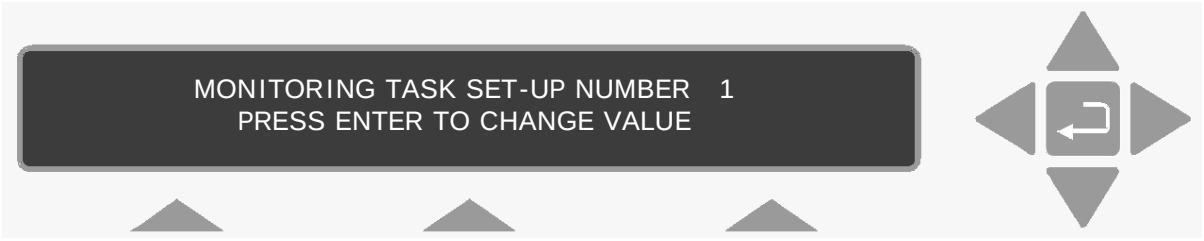
To enter the Set-Up Tree, press **SET-UP** and the monitor displays the following screen text.



1. Press **S1** to enter the **MEASUREMENT** branch. The new text displays two branches.

Monitoring Task branch

2. Press **S1** to enter the Monitoring Task branch.
   The following text is displayed:



3. Up to 10 different monitoring tasks can be defined here. These are labelled from 1 to 10. Use the direction push-buttons to select the desired set-up number and move on to the next display.

4. Use the select push-buttons to define if you want to sample continuously:
   If you select No (**S1**), go to step 5.
   If you select Yes (**S3**), go to step 6.

5. The sampling interval is displayed. Use the direction push-buttons to change it to the correct value.

6. Use the select push-buttons to define if you want to monitor for a pre-set period:
   If you select Yes, go to step 7.
   If you select No, go to step 8.

7. The monitoring period is displayed. Use the direction push-buttons to change it to the correct value.

   The **MONITORING PERIOD** is entered as Days Hours: Minutes. For example, if this particular measurement cycle needs to be performed during 5 days, 14 hours and 30 minutes, the “monitoring period” should be “entered” as 5 14:30. The Monitor

will then automatically stop monitoring 5 days, 14 hours and 30 minutes after the measurement cycle with this particular set-up number is started. The range of acceptable values and the default value of the monitoring period is shown in Table 7.8.

Table 7.8 The range of acceptable values and the default value of the monitoring period

Display Text	Acceptable Values	Default Value
ENTER MONITORING PERIOD	**days** **hours: minutes** 0 00:01 to 7 00:00	**days** **hours: minutes** 0 01:00

The Monitor's Display Memory has finite storage capacity. The data storage time available depends upon the number of gases being measured, as well as the frequency with which measurements are performed (that is, the sampling interval). Section 8.3 provides information about how you can roughly calculate the length of time the data from a particular monitoring task can be stored in the *Display Memory*.

It is important to realise that once the *Display Memory* has been filled up by the results of a particular monitoring task, the results of any further measurements in the same monitoring task will start to overwrite the data already stored in the memory.

8. Use the select push-buttons to define if you want to compensate for water vapour interference.

9. Use the select push-buttons to select the filters/gases you want to measure.

10. Use the select push-buttons to define if you want to measure water vapour.

11. Use the select push-button to define if you want to store the measurement history.

When step 11 is completed the display returns to the top of the branch.

Environment branch

12. Press **S3** to enter the Environment branch.

13. Use the select push-buttons to select the desired flushing mode.
    If you select Auto, go to step 16.
    If you select Fixed Time, go to step 14.

14. Use the direction push-buttons to define the Chamber Flushing Time.

15. Use the select push-buttons to select Tube Flushing.
    If you don't want tube flushing, select NO and go to step 17.
    If you select tube flushing, use the direction push-buttons to define the flushing time and go to step 17.

16. Use the direction push-buttons to select the desired sample tube length and move on to the next display.

17. Use the direction push-buttons to select the desired normalization temperature.
    See section 7.1 for details about the normalization options.

When step 17 is completed, the display returns to the top of the **MEASUREMENT** branch.

Press ▲ to go to the top of the Set-up Tree.

If you want measurement data presented as averaged concentration values, then go to step 19. If you want your measurement data presented as sample concentration values, then press **SET-UP** to exit the set-up function.

Format branch

If you are starting here, press **SET-UP**:

18. Press **S2** to enter the **FORMAT** branch.

19. Use the direction push-buttons to enter the correct averaging period.

20. Use the select push-buttons to choose if you want to print each gas.
    If you select Yes, go to step 21.
    If you select No, go to step 22.

21. Use the select push-buttons to choose which individual parameters should be printed. Each time one of the select push-buttons is pressed, the next parameter is displayed. This step can be repeated up to 7 times, depending on the number of filters installed.

22. Use the select push-buttons to select the Text line Terminator.

23. The text screen returns to the top of the set-up tree. Press **SET-UP** to exit the set-up tree.

If you want to set Alarm limits for the measured gases, go to section 7.3.

7.3 Setting-up the Monitor's Alarm Levels

The alarm limits of a gas are those concentrations of gas which should activate any alarm relay connected to the Monitor via its back panel "**Alarm Relay**" socket. There are two different alarm relays, which function slightly differently. Details of these relays and the way in which they function is described fully in section 5.5. The alarm level parameters are found in the **Filters** branch of the Set-Up Tree.

Warning! If the UA number for any filter is changed here, then all the calibration data for that filter will be lost and the filter will need to be recalibrated.

1. Press **SET-UP** **S3** **S3**. The following text is displayed

CHECK AND / OR CHANGE SET-UP FOR FILTER A
NO YES

2. Use the select push-buttons to ignore this filter or to select this filter if alarms are to be set.

3. Press ▼ 5 times until the following text is displayed.

GAS A HIGH ALARM LIMIT 1 _____mg / m³
PRESS ENTER TO CHANGE VALUE

4. Use the direction push-buttons to set the alarm concentration.

   If you do not wish to activate the alarm function for a particular gas, select the **DEFAULT**. This will "blank out" the alarm level value for the gas and deactivate the alarm for that gas.

GAS A HIGH ALARM LIMIT 2 _____mg/m³
PRESS ENTER TO CHANGE VALUE

5. Repeat steps 2 to 4 to set the alarms for the other filters.

6. Press **SET-UP** to exit the alarm set-up.

7.4 Starting a Monitoring Task

Monitoring tasks can be started in two ways. They can be started immediately, or set to start at a pre-set time. The duration of the monitoring sequence can also be determined. A monitoring task can continue until it is stopped manually, or at a pre-set time.

When using the PC and the Online option, there are no limits to the duration of a monitoring task. However, if the measurement results are being stored in the monitor's memory, the duration of the monitoring task should be considered as there is only a finite amount of memory in the monitor. See section 8.3 for full details about the storage capacity of the monitor.

7.4.1 PC Use – using the Online Program7810 Application SW

Please refer to user manual BE6027 for Application Software 7810 for assistance to set-up start and stop a monitoring task.

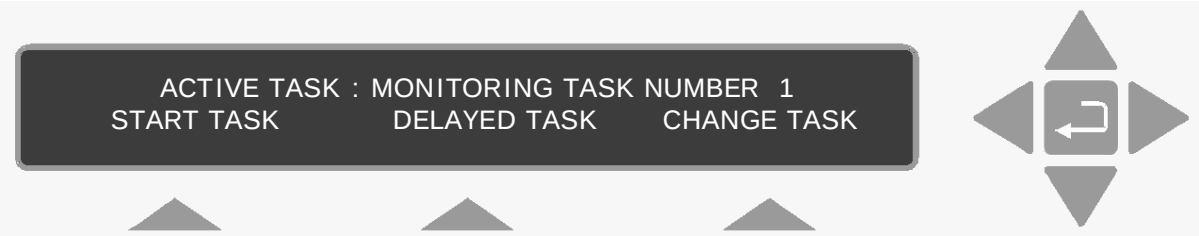
7.4.2 Stand-alone Use – using the Front Panel Push-buttons

Before a monitoring task is started, the set-up, as described in section 7.2, must be completed:

Before any monitoring task is started, all data stored in the Monitor's *Display Memory* is removed (cleared). The *Display Memory* is where the Monitor stores the results of all measurements while it is performing a monitoring task. However, the data in *Display Memory* can be copied into and stored in the Monitor's *Background Memory*. This operation is described in section 9.2.

When you start a new monitoring task the following warning is displayed **WARNING: DISPLAY MEMORY WILL BE DELETED** to remind you to store any data that is presently stored in the *Display Memory*. If a monitoring task is stopped, any data already stored in *Display Memory* will be deleted when a monitoring task is started.

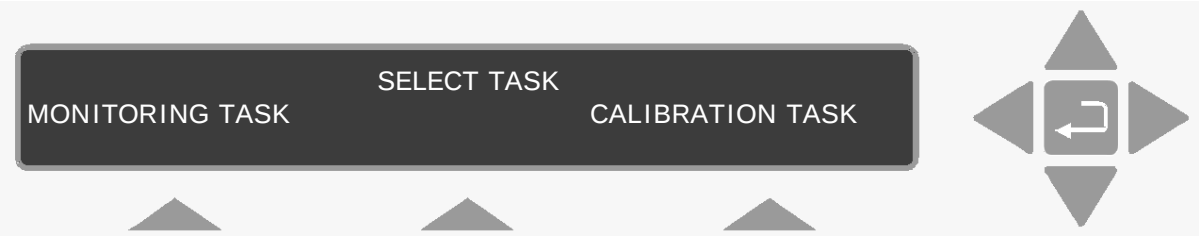
1. Press **MEASURE**.
   The following text appears on the screen:



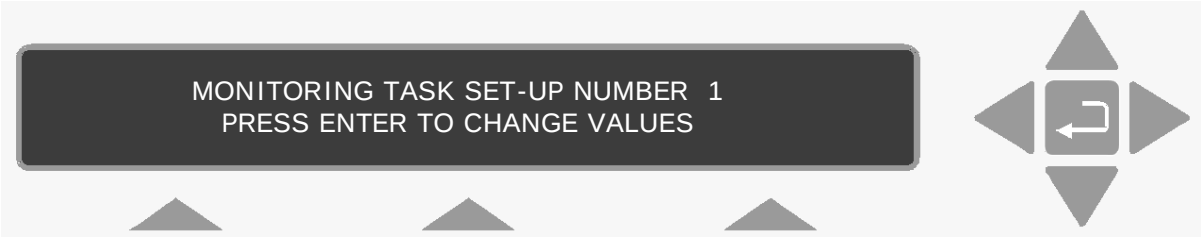
Please note: if you do not use one of the "select" keys within a short time after the above text appears, the Monitor will automatically stop operating in **Measure** mode (the light-emitting diode in the **MEASURE** key switches off). If this happens, just press **MEASURE** again.

The **active** monitoring task number is the number of the monitoring task you wish the Monitor to perform.

2. If the monitoring task number displayed is correct, then go to step 5.
   If the number on the display is **not** correct then press **S3** to change the task number.
   This changes the display text to the following:

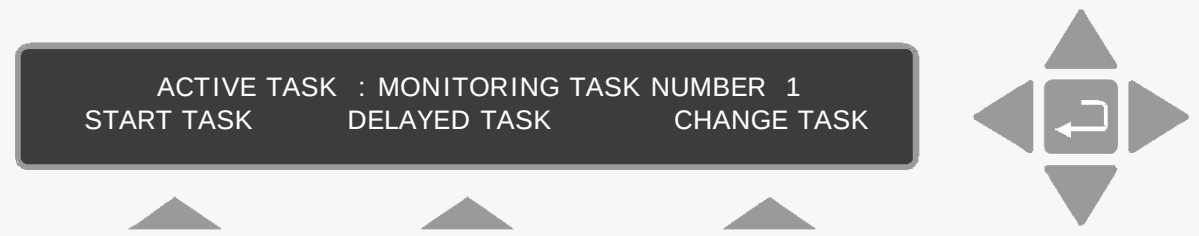


3. Press **S1**.
   This causes the following text to appear on the display:

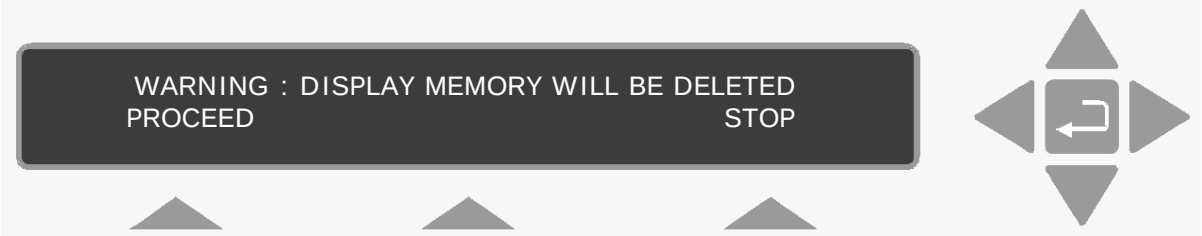


The number appearing on the screen will be a number from 1 to 10.

4. Press ↵ and use the direction keys to change the monitoring task number to the desired value. Then press ↵ again to accept the task number.
   The following text appears on the display screen:



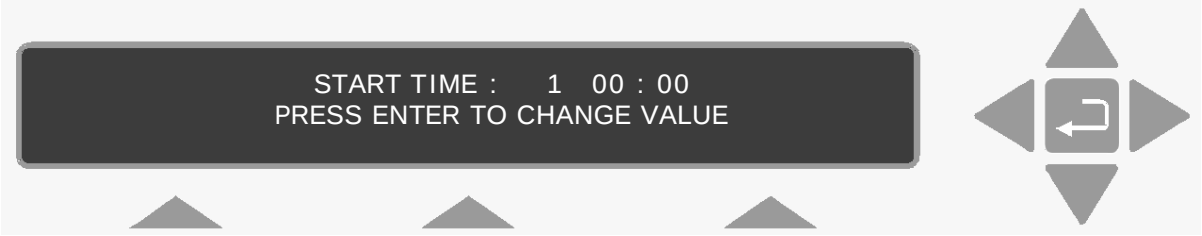
5. To start the measurement immediately, press **S1**.
   To delay the start, press **S2**.
   The following warning then appears on the display:



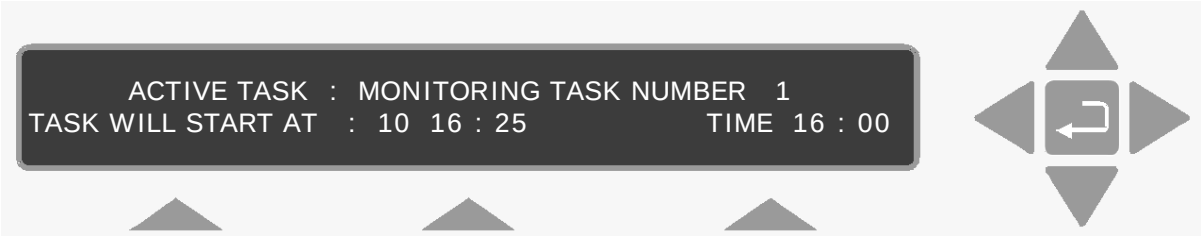
1. Press **S1**.

Delayed Start

If you selected a delayed start, the following text is displayed:



Use the direction push-buttons to enter the desired date and start time, e.g. 10 16:25. The following text is displayed.



When the monitoring task starts, the screen will change and display the same messages as those displayed when a monitoring task starts immediately.

Immediate Start

If you selected an immediate start, the following text appears on the screen:

MEASUREMENT IN PROGRESS
RESULTS NOT YET AVAILABLE

2. When the first measurement cycle is complete the Monitor will automatically display the results and update them every time a new measurement cycle is completed. An example is shown below:

This display gives the overview of the gas/vapour concentrations last measured – in this case the concentration of gas A and humidity of the water vapour are in the units that were selected – that is mg/m^3 for gas A and Tdew for water vapour (see section 4.3.2).

If no pre-set monitoring period is defined, then to stop the monitoring task, press **MEASURE** and **S3**.

Chapter 8

Viewing Measurement Data – Using the Monitor

April 2015

8.1 Displayed Monitoring Task Data

When the Monitor is switched on, but not being operated in any **mode**, the screen display text identifies the data stored in its *Display Memory*, by displaying the day and time of the first stored measurement cycle of the monitoring task, as well as the day and time of the last measurement cycle of the monitoring task. For example:

DATA IN DISPLAY MEMORY RECORDED FROM
2014-01-16 09:50 TO 2014-01-16 10:04

If the Monitor has just been **fully reset** then the display will just show the current time and report that the monitor is ready for use.

The Set-up parameters describing a monitoring task and the measurement data collected during the task are stored as a list in the *Display Memory*. You can scroll through the set-up parameters as well as the data collected during the task by using the direction push-buttons, ▼ to scroll "vertically" downwards, and ▲ to scroll "vertically" upwards through the list. Fig.8.1 illustrates how the data is organised:

Identification of Measurements:
This screen provides the date and time of the first and last measurement results, which are stored in *Display Memory*.

Identification of Each Monitored Gas:
This display identifies the gases monitored during the task. By using the ▶ push-button, one can find the names of **all** the gases, which were monitored during the displayed task.

Statistical Analysis of Measurement Results for Each Gas:
Using the individual measured gas concentration stored in *Display Memory*, when Store Measurement History is selected, a statistical analysis is performed which provides a summary of the stored measurement results. The MAX (maximum), MIN (minimum) gas concentrations are displayed, and the μ (Mean or Linear Average) and σ (Standard Deviation) values are calculated and displayed. A description of these statistical terms can be found in section 8.2.1. During the performance of a monitoring task the statistical analysis is updated constantly.

List of Individual Measurement Results:
Each of these displays provide the date and time each measurement cycle was performed and the concentration of the gas whose name appears on the screen. In some cases an asterisk (*) will be shown alongside the gas/vapour concentration. When such an asterisk is

shown, press the **INFO** button. Text will appear on the screen to indicate why this particular measurement has been marked.
The number which is shown on the display – between time and concentration – is only "filled-in" after completion of a monitoring task. The number indicates the order in which the measurements were made. The "oldest" **stored** measurement is always given the number 1 and the following measurements are numbered sequentially.

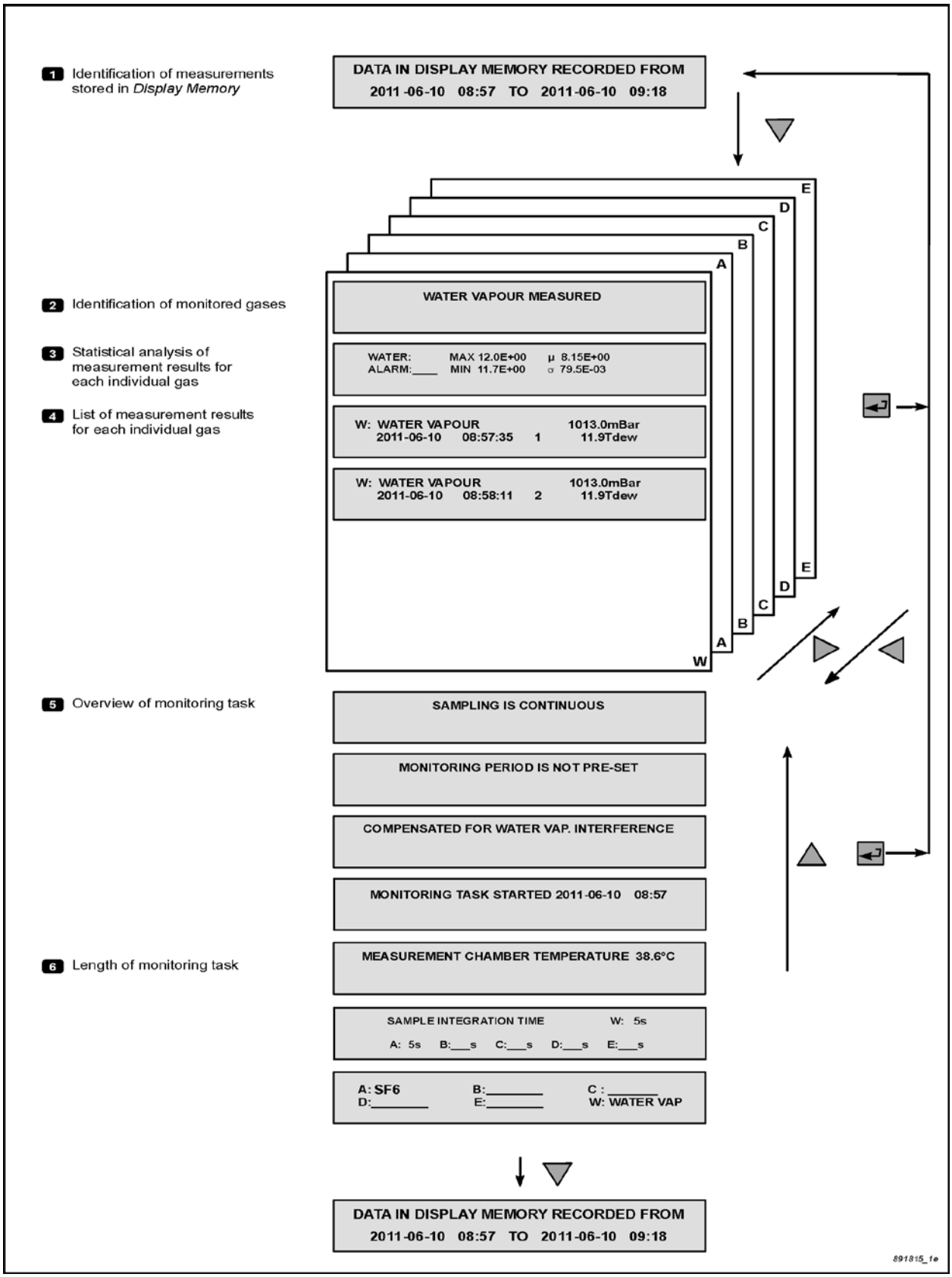
Overview of the Monitoring Task:
These displays provide an overview of the monitoring task set-up parameters.

Start of the Monitoring Task:
The *Display Memory* has a finite size and therefore, if a monitoring task runs for a long period of time, it will fill up all available memory space, and data collected after the memory has been filled-up will start to overwrite the data collected during the start of the monitoring task. Some measurement results will therefore be lost from the memory. In such a situation the date and time appearing after **MONITORING TASK STARTED.....** will not be the same as the first date and time displayed on the screen labelled **1** in Fig.8.1.

Using the direction push-buttons and the average push-button, users can scroll through each "page" of stored data and, in addition, average gas concentrations over a pre-defined averaging period. The functions of the push-buttons are described fully in Chapter 5 and can be summarized as follows:

AVERAGE When this push-button is pressed the 3436i will average the measurement results which are stored in its *Display Memory* over the period of time **Averaging Period** specified in the **FORMAT** branch of the Set-up "tree" (see section 7.2). When the averaging function is operative (the LED above the push-button is lit) only averaged measurement results are shown on the 3436i's display. These averaged measurements may also be printed out while the averaging function is operative. It is important to realise that when the averaging function is switched off the original measurement results will be shown again on the display. An example of averaged measurements is given in section 7.2.

Fig.8.1 Organisation of monitoring-task data displayed on the monitor's screen.


1 Identification of measurements stored in Display Memory
DATA IN DISPLAY MEMORY RECORDED FROM
2011-06-10 08:57 TO 2011-06-10 09:18
E
D
C
B
A
2 Identification of monitored gases
WATER VAPOUR MEASURED
3 Statistical analysis of measurement results for each individual gas
WATER: MAX 12.0E+00 μ 8.15E+00
ALARM:____ MIN 11.7E+00 σ 79.5E-03
4 List of measurement results for each individual gas
W: WATER VAPOUR 1013.0mBar
2011-06-10 08:57:35 1 11.9Tdew
W: WATER VAPOUR 1013.0mBar
2011-06-10 08:58:11 2 11.9Tdew
W
5 Overview of monitoring task
SAMPLING IS CONTINUOUS
MONITORING PERIOD IS NOT PRE-SET
COMPENSATED FOR WATER VAP. INTERFERENCE
MONITORING TASK STARTED 2011-06-10 08:57
6 Length of monitoring task
MEASUREMENT CHAMBER TEMPERATURE 38.6°C
SAMPLE INTEGRATION TIME W: 5s
A: 5s B:___s C:___s D:___s E:___s
A: SF6 B:_____ C : _____
D:_____ E:_____ W: WATER VAP
DATA IN DISPLAY MEMORY RECORDED FROM
2011-06-10 08:57 TO 2011-06-10 09:18
891815_1e

▶ &◀ Using these push-buttons users can scroll “horizontally” through any vertical level of data. For example, if the statistical analysis of the measurement results for water-vapour are displayed on the screen, then by using ▶ you can read the statistical analysis of the measurement results for gas A,W and then go back to the original display (see Fig.8.1).

EVENT This push-button can be used (pressed) to mark the measurement being performed at the time at which a special event occurred during a monitoring task. Any such measurement will appear on the display with an asterisk alongside it. By pressing **INFO** when such a display is seen you can display what the asterisk indicates. Section 8.2.2 shows the display which appears when **INFO** is pressed and explains all the symbols used. Marked events are also shown on print-outs and of monitoring task data (see section 8.2.3).

▼ This push-button allows the user to scroll “vertically” downwards through the list of measurement results (see Fig.8.1).

▲ This push-button allows the user to scroll “vertically” upwards through the list of measurement results. The measurement list is a closed loop.

The push-buttons ▲ and ▼ have a repetitive function, which means that if they are pressed continuously they will allow the user to scroll very quickly through a list.

8.1.1 Processing Measurement Data

Gas measurement data stored in *Display Memory* can be processed in the following way:

- It can be processed to produce Time-weighted Average (TWA) concentrations of gases over any user-defined period of time.

8.1.2 Obtaining Time-weighted Average (TWA) Values

By using the **AVERAGE** button Time-weighted Average concentrations (C_{TWA}) of all the monitored gases can be obtained over any user-defined period of time (T hours). The following steps are involved:

1. Press **SET-UP** and **S2**.

2. “Enter” the period of time required for averaging – this could for example be 8 hours if you are interested in finding out whether the 8 hour Time Weighted Average concentration of gases are in compliance with National Occupational Exposure Limits; or, alternatively, the averaging period could be 15 minute Time-Weighted Average if you are interested in finding out whether the Short Term Exposure Limit (STEL) of the gases complies with National Occupational Exposure Limits.

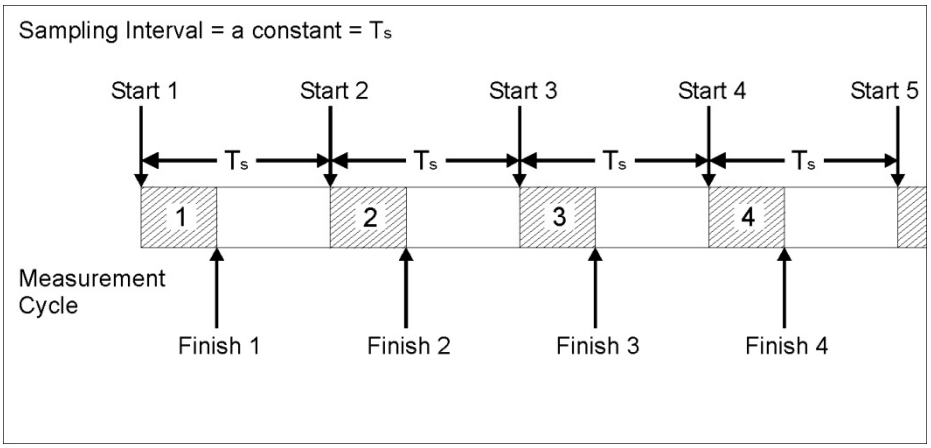
3. Press **SET-UP** and then **AVERAGE**.

When steps 1 to 3 are complete, scroll through the measurement results displayed on the screen (*Display Memory*). Notice that all measurements have been averaged over the chosen averaging period. A detailed example is given in section 7.2.

8.1.3 How Time-weighted Averages are Calculated

In order to explain how the 3436i averages gas measurements over a fixed user-defined “averaging period”, let us suppose that a particular gas has been monitored continuously and that its measured concentration was C_1 during the first sampling interval T_1 min, C_2 during the second sampling interval T_2 min…. C_n during the n^{th} sampling interval T_n min (see Fig.8.2). Suppose that you wished the 3436i to calculate the Time-weighted average (TWA) over a period of time = T min.

Fig.8.2 Illustration of a monitoring task



The Time-weighted average of these measurements over the averaging period of T min is calculated using the following mathematical equation:

$C_{TWA} = \frac{\sum_{n=1}^{n=N}(C_n)}{N}$ = linear average of all the measurements made during the averaging period.

Where: Cn = constant concentration measured at time Tn;
N = the total number of measurements performed during the averaging period T min.

In the situation where the total monitoring period is the same as the averaging period then the averaged value of the **last** performed measurement will be the same as the Mean Value (μ) shown on the display screen (see 3 in Fig.8.1).

8.2 Printed Monitoring Task Data

Fig.8.1 illustrates how data from a monitoring task is displayed on the Monitor's screen. When monitoring task data appearing in *Display Memory* is printed out, the same information appears but it is presented in a different format. An example of a monitoring task data print-out is shown in Fig.8.3 – Chapter 10 describes how this is done.

Fig.8.3 Print-out of monitoring task data

```
- 3436i Measurement Data ------- 620-002/9441 - 2015-01-18 09:22 - Page  1 -


3436i Settings:
------------------------------------------------------------------------

Compensate for Water Vap. Interference   :              YES
Compensate for Cross Interference        :               NO
Sample Continuously                      :              YES
Pre-set Monitoring Period                :               NO
Store Measurement History                :               NO

Measure
Gas A: SF6                               :              YES
Water Vapour                             :              YES

Flushing Mode                            :             AUTO
Sampling Tube Length                     :             0.00 m
Normalization Temperature                :             20.0  C

Sample Integration Time
Filter A                                 :                5 s
Filter W                                 :                5 s

General Information:
------------------------------------------------------------------------
Start Time                               : 2015-01-18 08:43
Stop Time                                : 2015-01-18 09:13
Results Not Averaged
Number of Event Marks                    :                0
Number of Recorded Samples               :                1

             Alarm 1    Alarm 2        Max       Mean        Min    Std.Dev
------------------------------------------------------------------------
Gas A:       ________   ________   6.69E-03   3.00E-03   -2.2E-03   ________
Water:       ________   ________   4.98E+00   4.38E+00   4.32E+00   ________
```

8.2.1 Statistical Analysis Terms

In the statistical analysis of the measurement results for each gas (see **3** in Fig.8.1) the following statistics appear:

The Mean Value (μ) – this is the linear average of all measurements of a gas taken during the total monitoring period. The calculation of "the mean value" can be expressed mathematically as follows:

$$\text{The Mean Value} = \mu = \frac{\sum_{n=1}^{n=N}(C_n)}{N}$$

Where: N = measurement cycles performed during the monitoring period (T) between the cursors.
c_n = gas concentrations (where n = 1 to N)

The Standard Deviation (σ) – this is the standard deviation of a particular gas's measurements from the mean value (μ) of this gas. Standard deviation can be expressed mathematically as follows:

$$\text{The Standard Deviation} = \sigma = \sqrt{\frac{\sum_{n=1}^{n=N}(Cn-\mu)^2}{N-1}}$$

Where: μ = the mean value
C_n = individual gas concentrations
N = total number of measurements

8.2.2 Symbols used in Displayed Measurement Data

If an asterisk (*) appears on the display alongside any gas concentration, it indicates that something happened during the measurement. You can find out what the asterisk indicates by pressing the **INFO** button. The following display appears for a short period of time:

GAS X: COMMON MARK: PEOW GAS MARK: BFA
EVENT NO: xxxx TIME: hh:mm

"EVENT NO" will appear on the screen only if the Event Mark button was used during the monitoring task. In this case the letter "E" will also appear as a Common Mark. The symbols which can appear after the text **COMMON MAR**K and **GAS MARK** are listed below with a short explanation of what they mean:

Common Marks:

"P" (1) The Monitor stopped measuring due to a power failure but has automatically re-started the monitoring task again after regaining power;
(2) The Monitor has been "reset" either because of a detected fault or because **RESET** was pressed.

"E" The measurement has been marked by the User**.**

"O" This symbol indicates that an operational error was detected during this measurement. The accuracy of such a measurement cannot always be guaranteed.

"W" This symbol indicates that a warning was detected during this measurement. The accuracy of such a measurement cannot always be guaranteed.

Gas Marks:

"B" The Monitor was incapable of calculating this gas concentration.

"F" After this measurement the filter carousel was found to be out of alignment. If the carousel was only slightly out of alignment then the accuracy of the measurement has not been affected. The accuracy of such a measurement cannot always be guaranteed.

"A" The gas concentration measured during this measurement cycle was found to exceed the user-defined alarm limit for this gas.

8.2.3 Symbols Used in Print-outs of Measurement Data

Displayed measurements marked with the **COMMON MARKS "O"** and **"W"**, and the **GAS MARKS "A"** and **"F"**, are printed-out with an "X" symbol. However, any displayed measurements marked with the **COMMON MARKS "P"** and/or **"E"**, and the **GAS MARK "B"** are not printed-out with these symbols. These measurements are marked in a different way:

Common Marks:

The symbol **“P”** is replaced by the text **“3436i Restarted”**. This indicates that the Monitor stopped and then started-up again sometime between the previous sample time and the time which appears alongside this message.

The symbol **“E”** is replaced by the text **User Event NumberX:** This indicates that the EVENT button was pressed while this measurement cycle was being performed. The number indicates the total number of “events” which have been marked during this monitoring task, at the time this sample was taken.

Gas Marks:

The symbol **“B”** is replaced by a straight line (_____) which indicates that the Monitor was unable to calculate the concentration of the named gas in this sample.

Other Marks Used:

……This symbol indicates either: (1) that this gas was not measured; or (2) that this gas was not selected to be printed out (see section 10.5).

8.3 Storage Space in the Display Memory

The total space available in the *Display Memory* to store data is 131072 measurement cycles. Depending on the time for one measurement cycle the capacity will be as follows.

If a measurement cycle in which gas A and water vapour are measured with continuous sampling takes 15s, then the Display memory space will be 546 hours = 22 days.

The Monitor will overwrite the oldest stored measurement data when the Display memory is full. This is done by deleting data in blocks of 2048 measurement cycles.

For further information regarding measurement cycles see chapter 4.

Chapter 9

Storage of Data in the Monitor's Memory

April 2015

In order to fully understand the functioning of the Monitor it is necessary to know something about the different types of memory the Monitor uses, the kind of data stored in each type of memory, and how this data is affected by the various operations performed by the Monitor.

Offline users may find the information in this chapter of interest as their measurement data is stored in the Monitor's memory before being uploaded to the PC.

9.1 Types of Memory in the Monitor

The Monitor has three types of memory:

1. A **R**ead **O**nly **M**emory (**ROM**);
2. An **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory (**EEPROM**), which we have named the ***Source Memory***;
3. A **R**andom **A**ccess **M**emory (**RAM**) which we have named the ***Working Memory***.

9.1.1 Read Only Memory (ROM)

Data stored in this memory cannot be changed by the user. The **Optical Filter Factors**, which describe each of the optical filters, which are available for installation in the Monitor, are stored in this memory. These factors are listed in a print-out of the "Calibration Data Block" (see section 10.7).

When optical filters are installed in the carousel wheel, the Monitor must be informed about:

- **Which** filters have been installed in its carousel (UA numbers of the filters);
  and
- **Where** they have been installed (position "A" – "E" of the carousel – see section 12.3.3).

This information allows the Monitor to read the correct optical filter factors from its **ROM** memory when the filter is installed. As these factors are used in the calculation of calibration factors, it is **vitally important** that this information is correctly entered **before** calibration is performed.

9.1.2 Source Memory (EEPROM)

The data stored in ***Source Memory*** is not lost if A.C. mains power is removed from the Monitor. There are three blocks of data in the ***Source Memory*** (see Fig.9.1):

Block 1 – contains calibration factors and 3 optical-filter parameters
Block 2 – contains 3 of the 6 set-up parameters found under the **Filters** branch of the set-up "tree"
Block 3 – contains all other parameters in the Set-Up Tree

Block 1 – Calibration Factors and 3 Optical-filter Parameters:

There are six different "data files" in this block. Each data file is denoted by a letter, which indicates the position a particular optical filter occupies in the Monitor's carousel. Each file "A" to "E" is divided into **five** sections called **Filter Banks**, which are numbered from 1 to 5. The water-vapour filter is only capable of measuring water-vapour and therefore its data file ("W") is not divided into different filter banks.

Each **Filter Bank** contains the following data:

1. The name of the gas used during span calibration of the filter.

2. The molecular weight of the gas used during span calibration.

3. The alarm limits for the gas. (High Alarm Limit 1, High Alarm Limit 2).

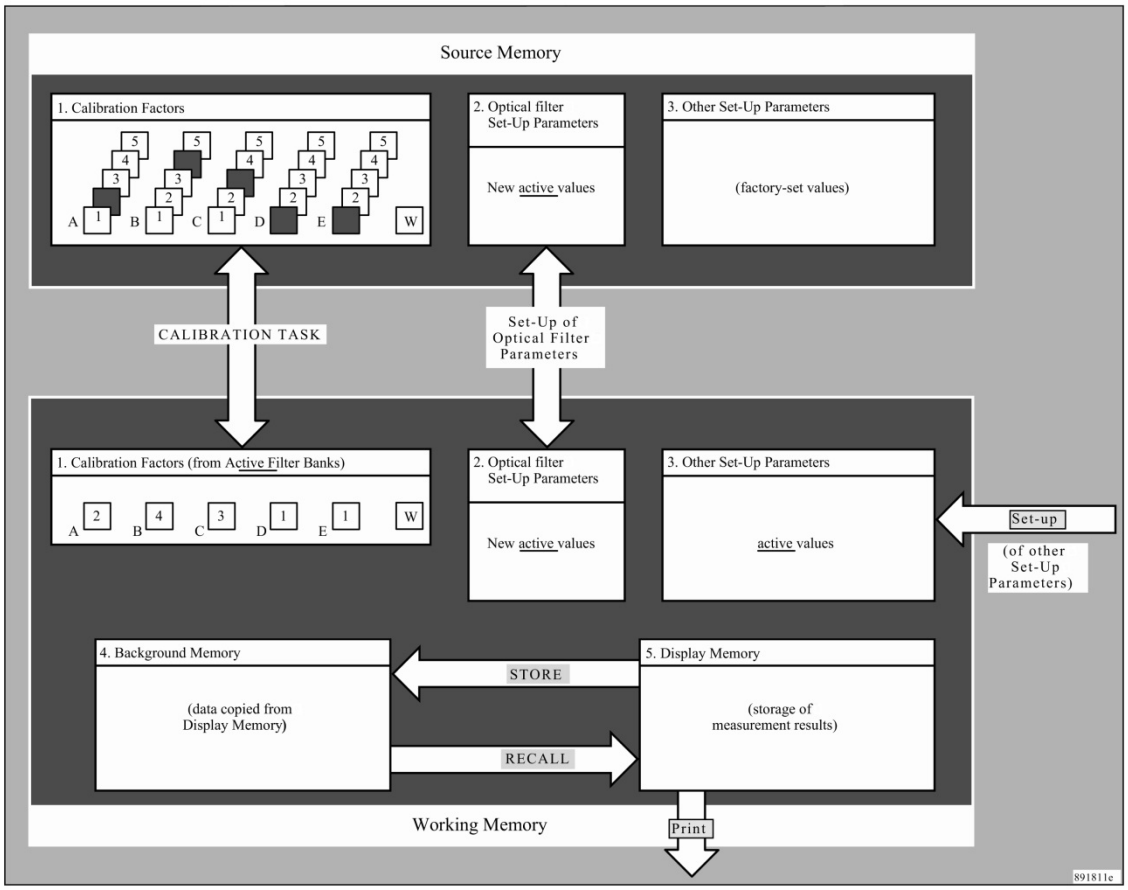
4. A **Concentration offset factor:** obtained during zero-point calibration of the filter.

5. A **Humidity gain factor:** obtained during a humidity-interference calibration of the filter.

6. A **Conversion factor:** obtained during the span calibration of the filter with the gas named in point 1 above.

7. **Cross-interference calibration factors:** obtained during cross-interference calibration (not valid for 3436i only one optical filter is installed).

Fig.9.1 Schematic diagram showing the structure of the Monitor's memory



Before calibrating a particular filter, one of the filter's banks is made **active** (by operating the Monitor in **Set-Up mode** and "entering" the chosen filter-bank number for the filter being calibrated). The filter bank No. which is made **active** before the filter is calibrated, is the filter bank where the Monitor will store calibration factors calculated during calibration. This means that the user is able to calibrate any particular optical filter to measure up to **five** different gases.

If a particular filter is to measure more than one gas, it is therefore necessary to **span** calibrate it with each of the gases it is to measure. For example, if you refer to the **"Gas Detection Limits"** wall chart you will see that the filter UA 0936 can be used to measure

1 Sulphur hexafluoride

The filter UA 0936 is installed in position "A" of the filter carousel to measure the above gas. Before this filter is calibrated, the Monitor has to be told where to store the calibration factors which are calculated during the calibration procedure. This is done by selecting a **FILTER BANK NO.** – in the active set-up for Filter A each time the

filter is calibrated. For example, Filter Bank No.”1” for storage of the calibration factors for Sulphur hexafluoride.

After calibration of the filter UA 0936 the Monitor is able to accurately monitor the gas mentioned. By selecting the correct **FILTER BANK NO.** in the set-up of the Monitor before a monitoring task is started, the user determines which calibration factors will be used during the task. For example, when Filter Bank No.”1” is entered in the **active** set-up for filter UA 0936 in position ”A”, the Monitor reads the calibration factors from file “A1” into its ***Working Memory*** .

Block 2 – Optical Filter Set-up Parameters:

This block contains 3 of the 6 parameters, which describe the optical filter installed in each position of the filter carousel:

UA number of the filter;
Filter bank number;
S.I.T. information;

If any of the above-listed parameters are changed in the **active** set-up they are also automatically changed in the ***Source Memory***.

Block 3 – Other Set-Up Parameters:

This block of data contains all set-up parameters except the optical filter parameters. Before leaving the factory the parameters in this block are given factory-set values. These are the values obtained for a parameter when the **Default** button is pressed.

9.1.3 Working Memory (RAM)

The ***Working Memory*** is a “volatile” memory, that is, data will be lost from it if electric power is removed from the Monitor. When the Monitor is not connected to a mains power supply a lithium battery in the Monitor provides a back-up power supply to protect the data in this memory. When this battery is no longer providing enough power a warning **BACK-UP BATTERY TOO LOW** will appear on the Monitor’s display to indicate that the battery needs to be replaced by a new one.

There are four different blocks of data in the ***Working Memory*** (see Fig. 9.1):

Block 1 – contains only calibration factors and 3 optical-filter parameters from the active “Filter Bank”.

Block 2 – contains 2 of the 5 optical filter parameters with values which are the same as those found in Block 2 of the ***Source Memory***.

Block 3 – contains all other set-up parameters (i.e. excluding the optical filter parameters) with **active** set-up values.

Block 4 – contains data collected during the performance of a monitoring task. This data block is named the *Display Memory* because this data is displayed on the Monitor's screen while a monitoring task is being performed.

Block 5 – this block contains measurement data, which was copied into it from the *Display Memory*. This block is called *Background Memory* because the data stored in it cannot be **accidentally** deleted.

Block 1 – Calibration Factors and 3 Optical-filter Parameters from the Active Filter Bank:

If, one optical filters are installed in the Monitor and the UA0936 have been entered in the **active** set-up and Filter Bank No.1 has been selected for filter "A"; then only calibration factors from filter banks A1 and W will be stored in this block of data (see Fig. 9.1). The name, molecular weight and alarm limits of each gas will also be stored in this block.

Block 2 – Optical Filter Set-up Parameters:

Whenever the optical filter's **active** Filter Bank Number is changed, the same values are automatically read into Block 2 of the ***Source Memory***.

Block 3 – Other Set-up Parameters:

The **active** set-up values are those values, which are underlined by a cursor on the display screen of the Monitor when it is operated in **Set-Up** mode.

Block 4 – Measurement Data:

Whenever the Monitor performs any operation, which results in data occupying the *Display Memory*, the data already stored there will be deleted. To reduce the risk of accidental losing data from *Display Memory*, a **warning "WARNING: DISPLAY MEMORY WILL BE DELETED"** is displayed whenever a user attempts to perform an operation with the Monitor, which will result in the deletion of data from *Display Memory*.

Data in *Display Memory* can be copied into the Monitor's *Background Memory* (see Block 5 below) to protect it against accidental deletion.

Alternatively, the data in *Display Memory* can be printed out by connecting a printer to the Monitor and transmitting data via the RS 232 interface port of the Monitor (see Chapter 10).

The storage space in *Display Memory* is finite. Once this memory has been filled by data from a monitoring task any additional data collected will start to overwrite some of the data already stored there.

Block 5 – Stored Measurement Data:

By selecting to **STORE** data when the Monitor is operating in M**emory** mode the user can copy data from *Display Memory* into *Background Memory* to "protect" data against accidental deletion from the *Display Memory* (see section 9.3.1 for further details).

The storage space in *Background Memory* is finite and is exactly the same size as the storage space available in *Display Memory* (see section 8.3 for further details).

Data which has been stored in *Background Memory* can be recalled to the *Display Memory*. This is done by operating the Monitor in **Memory** mode and selecting to **RECALL** data (see section 9.3.2). When data is "recalled" to *Display Memory* it is not **transferred** from *Background Memory* to *Display Memory*, it is only **copied** into *Display Memory* so there is no risk of losing it. In *Display Memory* the user can scroll through the data.

Data stored in *Background Memory* can be deleted by operating the Monitor in **Memory** mode and selecting to **DELETE** data (see section 9.3.3).

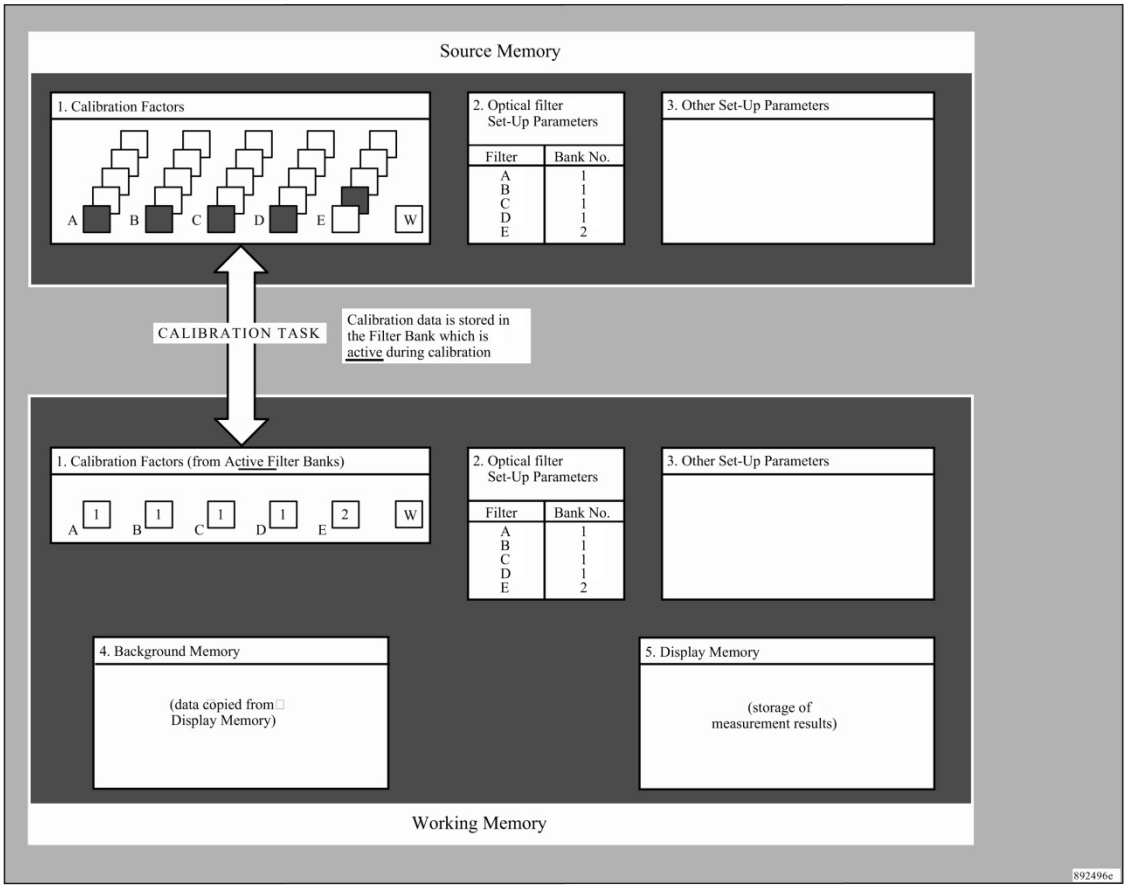
9.1.4 Effect of a Calibration Task on the Monitor's Memory

Before calibration of the optical filters in the Monitor the UA number of the installed filter is "entered" into the **active** set-up of the Monitor. This enables the Monitor to find a set of numerical parameters, which describe the optical filter (this information is found in the **R**ead **O**nly **M**emory of the Monitor). These numerical parameters are called Optical Filter Factors.

During a **CALIBRATION TASK** the Monitor uses the Optical Filter Factors to calculate the calibration factors for the installed optical filter. As explained in section 9.1.2, by "entering" a Filter Bank No. in the **active** set-up before calibration of the particular filter with the particular gas, each filter can be calibrated to measure up to five different gases and the filter bank number tells the Monitor exactly

where (in the ***Source Memory***) to store the calibration factors calculated during the calibration task.

Fig.9.2 The state of the Source Memory after completion of a ***CALIBRATION TASK***



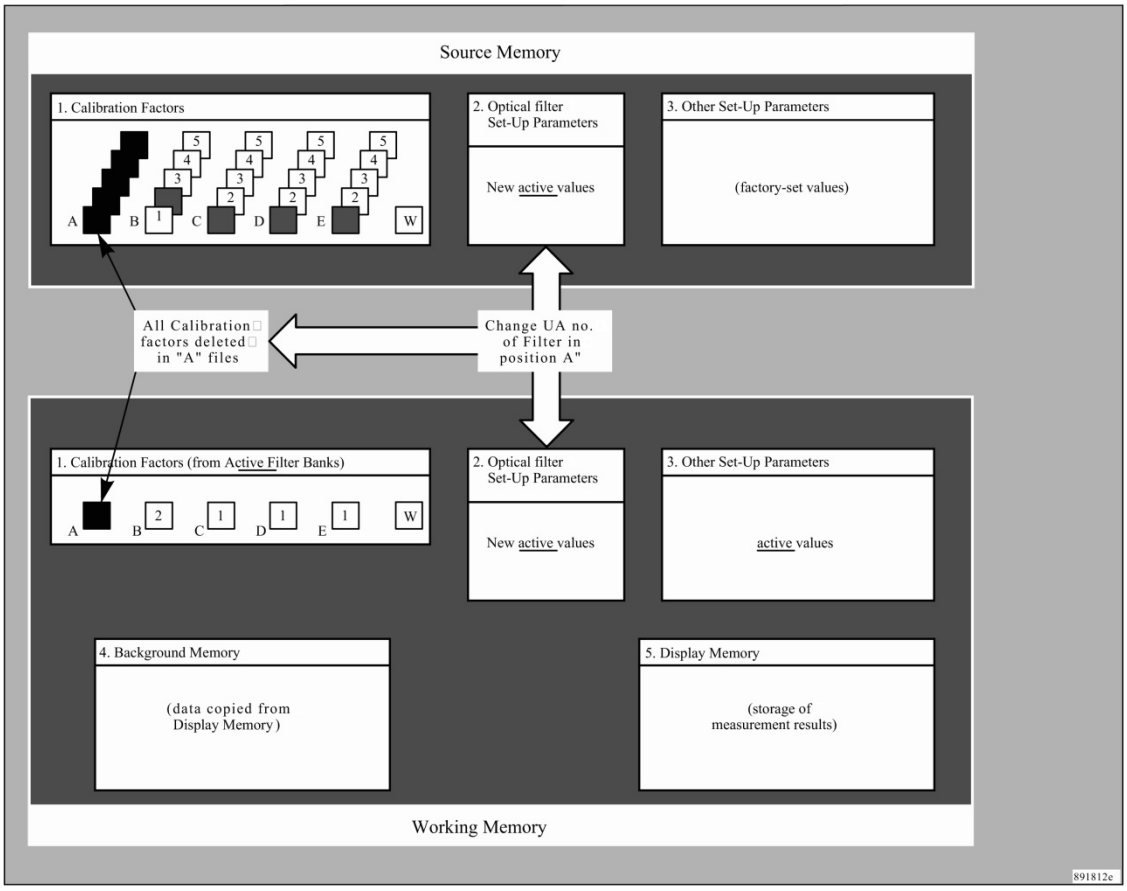
After completion of a calibration task the calibration factors, which are found in the ***Working Memory,*** are entirely dependent upon the Filter Bank No., which is **active** for the optical filter. If Filter Bank No. 1 is **active** for the filter in positions "A" then calibration factors from files A 1, W will be found in ***Working Memory*** (see Fig 9.2).

9.1.5 Effect of Changing the UA number in the "Active" Set-up

WARNING!: *Changing the UA number of the filter in the Monitor's active set-up will destroy all calibration data for the filter.*

As explained in section 9.1.1, the UA No. determines the set of Optical Filter Factors used during the calculation of calibration factors and therefore, if the UA number of the filter is changed in the **active** set-up of the Monitor, all calibration data related to the optical filter has been removed from the set-up is **automatically** deleted from both the ***Source Memory*** and the ***Working Memory*** as it is no longer valid.

*Fig.9.3 Effect of changing a UA number in the **"active" set-up***



For example, if the UA number of the filter installed in position "A" of the filter carousel is changed in the **active** set-up then calibration factors are deleted from the active file "A" in the ***Working Memory*** and from files A 1, A 2, A 3, A 4 and A 5 in the ***Source Memory*** of the monitor (see Fig.9.3). The Monitor will not be able to measure any gas with filter "A" until it has been fully calibrated, see Chapter 12 for details.

9.1.6 Effect of a Full Reset on the Monitor's Memory

A **FULL RESET** of the Monitor changes the data stored in its ***Working Memory*** as follows:

1. All data stored in *Display Memory* and *Background Memory* is deleted.

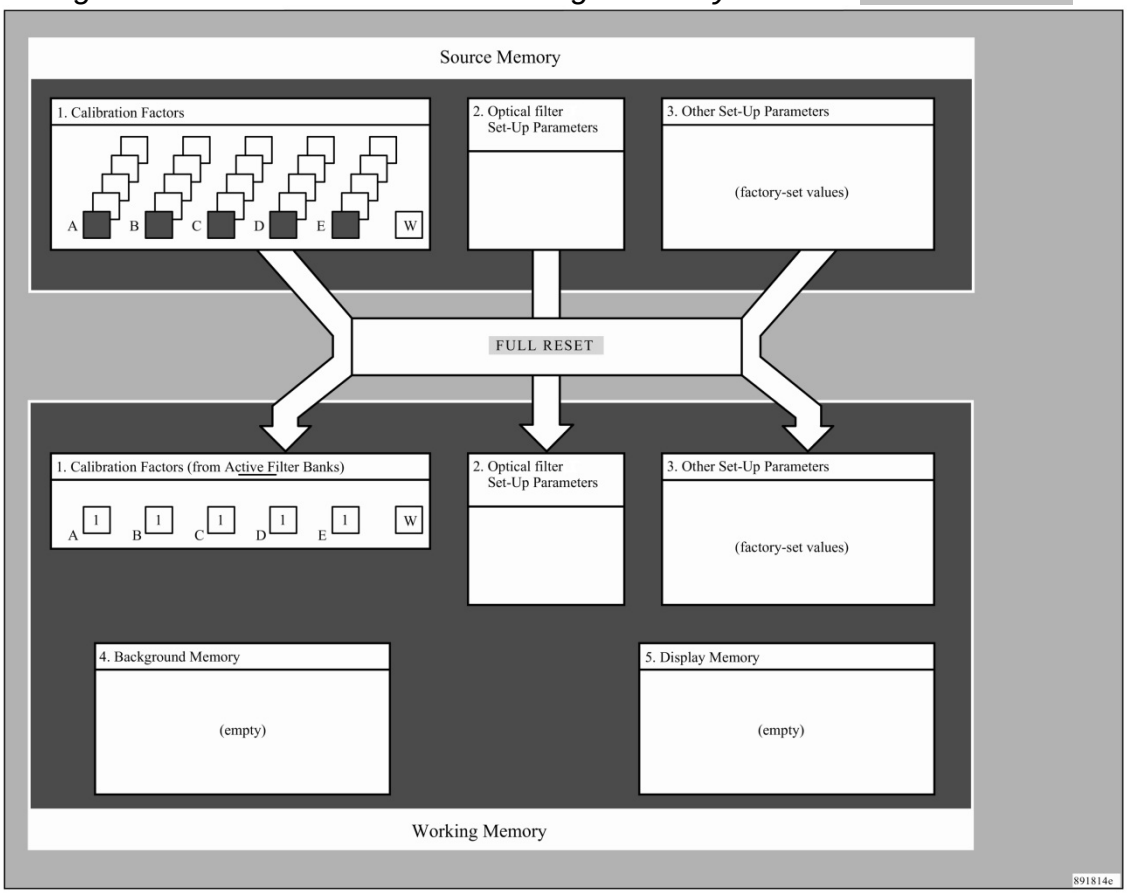
2. Values of the Optical Filter Set-up Parameters in Block 2 of The ***Source Memory*** are copied into Block 2 of the Working Memory.

3. The **active** values of the other set-up parameters in Block 3 of the ***Working Memory*** are replaced by the factory-set values defined in Block 3 of the ***Source Memory***.

4. The **active** values of the Optical Filter Parameters in Block 2 of the ***Working Memory*** are replaced by the values of the optical filter parameters in Block 2 of the ***Source Memory***. Note that under normal circumstances the data in these blocks is the same. However, to ensure that the data in these blocks **is** the same, data is read from ***Source memory*** into the ***Working Memory*** during a **FULL RESET** of the Monitor.

5. Those Filter Bank Nos. which have been made **active** determine the calibration factors which will be found in Block 1 of the ***Working Memory*** after a **FULL RESET** of the Monitor. If, for example the **active** Filter Bank No. chosen for all the filter "A" is no. 1, then only the calibration data in files A 1; and W will be found in the Monitor's ***Working Memory*** after a **FULL RESET**. This example is illustrated in Fig.9.4.

*Fig.9.4 The state of the Working Memory after a **FULL RESET***



9.2 Storage of Measurement Results

While a monitoring task is being performed measurement data is stored in the Monitor's *Display Memory*. When the monitoring task is complete the data in Display Memory is normally copied into the

Monitor's *Background Memory* to prevent it from being overwritten (and therefore lost) by measurement data stored during the next monitoring task. The same amount of data can be stored in both the *Background Memory* and the *Display Memory*.

Structure of the Background Memory:

The data from a maximum of 10 monitoring tasks can be stored in the *Background Memory* provided the total amount of data from the 10 tasks does not exceed the total capacity of the *Background Memory*. Each monitoring task stored in the *Background Memory* is given a "location number" (from no. 1 to no. 10). The size of each location is flexible and is equal to the space required to store all the data collected during a monitoring task. Each monitoring task stored will occupy at least 2% of the total Memory capacity.

If data from a single monitoring task totally occupies the *Display Memory*, then this data can be stored in *Background Memory* provided that no data is already stored there. The data will occupy only one location of *Background Memory* and fill all available storage space. Therefore, it will not be possible to store any data from any new monitoring task in *Background Memory* unless the data already stored there is first deleted (see section 9.3.3).

To illustrate the variable size of each location let us suppose that the following monitoring tasks are performed:

Task No. 1: The data collected in *Display Memory* occupies 20% of the total capacity of the *Display Memory*. The data can be stored *in Background Memory* provided that the data already stored there occupies less than 80% of the total capacity of the *Background Memory*. However, let us suppose that the *Background Memory* is empty and that we **STORE** the data from this monitoring task in location 1 of *Background Memory*. This means that *Background Memory* is now 20% full (see Fig.9.5).

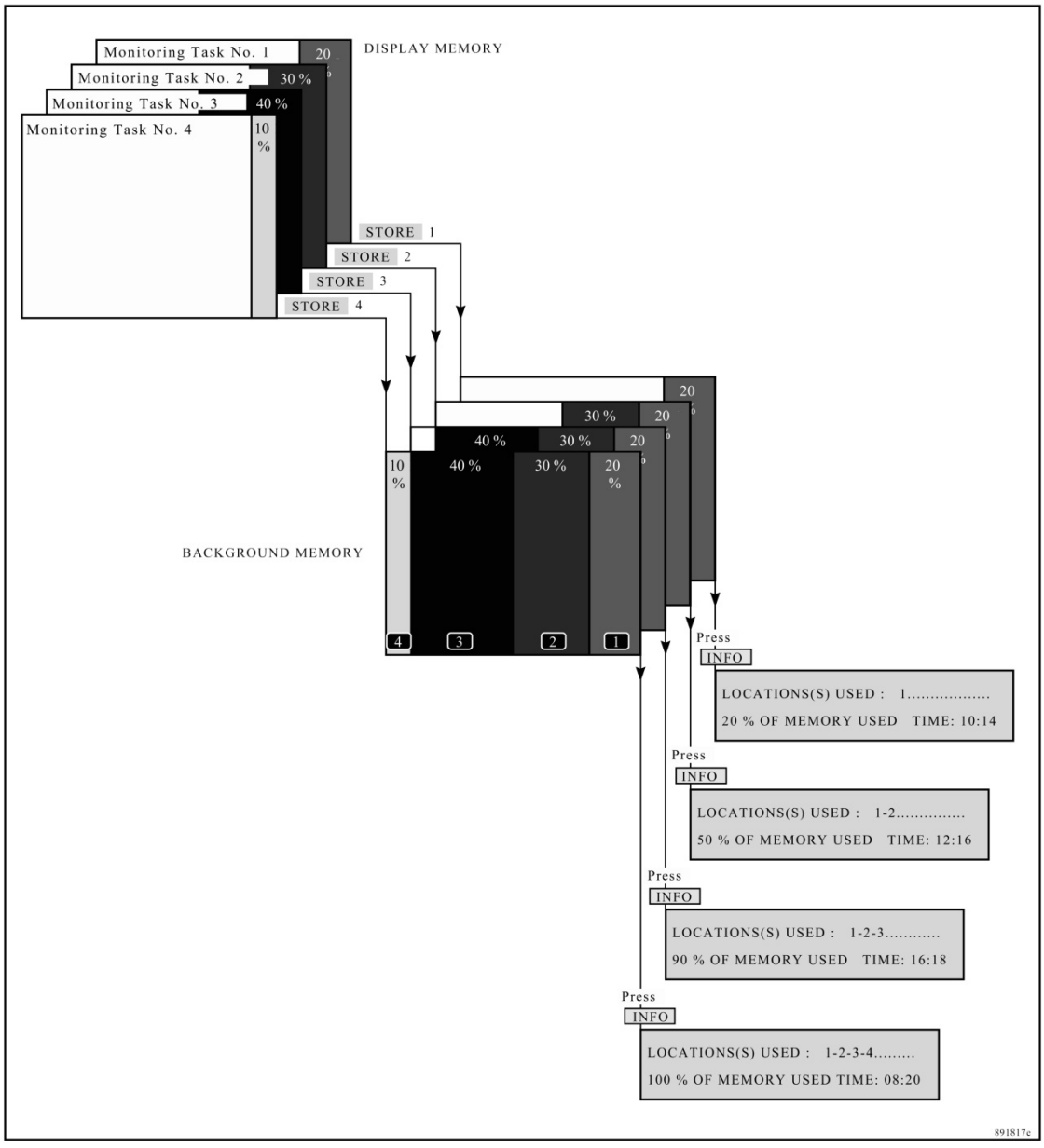
Task No. 2: The collected data occupies 30% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data in location 2 of *Background Memory*. This means that *Background Memory* is now 50% full (see Fig.9.5).

Task No. 3: The data occupies 40% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data from this task in location 3 of *Background Memory*. *Background Memory* is now 90% full (see Fig.9.5).

Task No. 4: The data occupies 10% of the total capacity of the *Display Memory*. Let us suppose that we **STORE** the data from this task in *the Background Memory* – let us say it is stored in location 4. *Background Memory* is now 100% full (see Fig.9.5).

The *Background Memory* has now been filled-up by the data from the four monitoring tasks described above, even though location nos. 5 – 10 (inclusive) has not been used. The user will not be able to **STORE** any more data in *Background Memory* because there is no space available for it. Data in *Background Memory* can, however, be deleted to make space for the storage of new measurement results (see section 9.3.3).

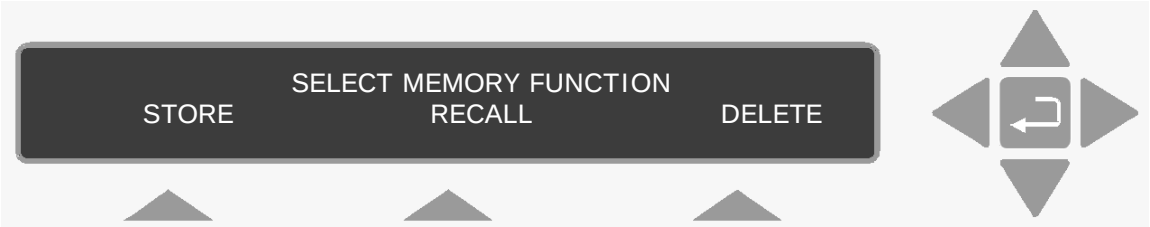
Fig.9.5 Storing data from 4 different consecutive measurement tasks in the Background Memory.



Whenever the Monitor is operating in Memory **mode** the user can, by pressing the **INFO** push-button, find out what percentage of the *Background Memory* is occupied and which location numbers have been used to store data. Fig.9.5 illustrates the status information one can obtain from the Monitor during various stages of the four monitoring tasks described above. Further information about the **INFO** push-button can be found in section 9.3.4.

9.3 Management of Data in Background Memory

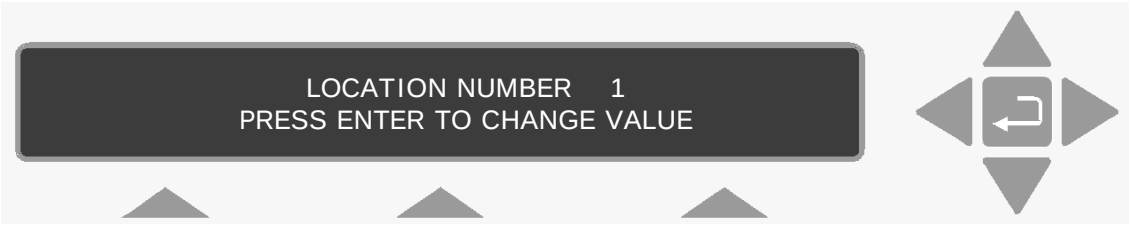
The monitor has to be operated in Memory mode by pressing the **MEMORY** push-button. The following text appears on the screen:



9.3.1 Storing Data in Background Memory

When data is to be copied from *Display Memory* into *Background Memory*:

Press **S1**

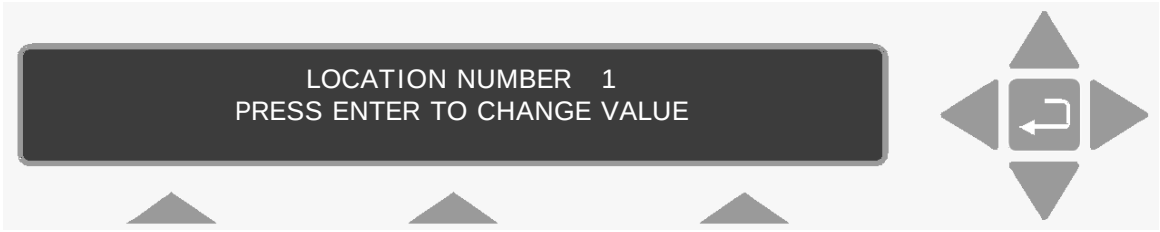


If some data has already been stored in the *Background Memory* and you cannot remember which locations have been occupied (used), press the **INFO** push-button to find out which locations are occupied and what percentage of the *Background Memory* has been used (see section 9.3.4). Use the direction keys to select the desired location number. When the chosen location number is on the screen, press **S2** to accept the position.
Press **Memory** to exit.

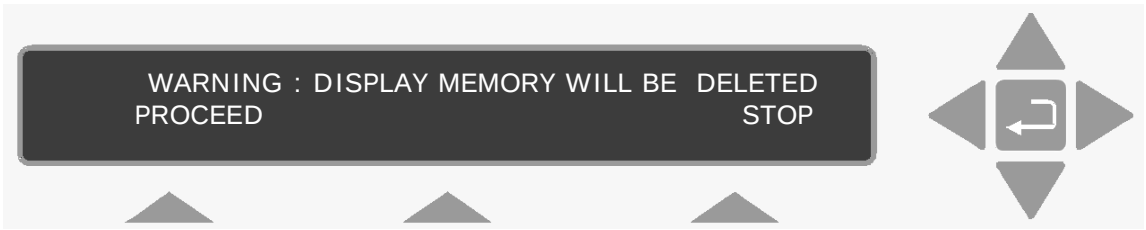
9.3.2 Recalling Data from Background Memory

To recall data stored in *Background Memory* to *Display Memory*:

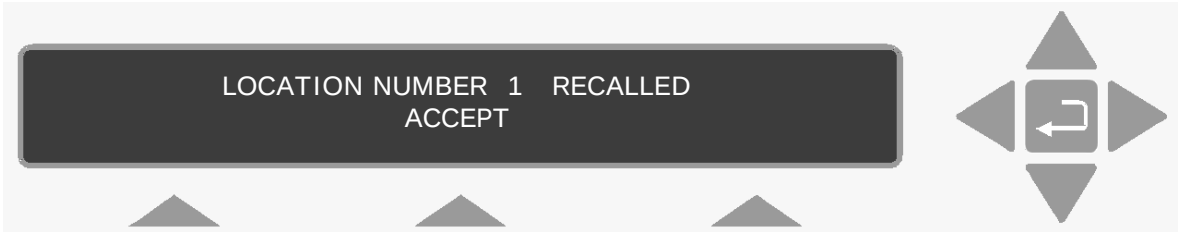
1. Press **Memory** **S2**.



2. Use the direction keys to select the correct location number. The following text is displayed.



3. If you want to continue, press **S1**, and the following text is displayed.



If you want to Stop, press **S3**, this returns you to the original display showing **SELECT MEMORY FUNCTION** so that you can **STORE** any data which is stored in *Display Memory* as explained in section 9.3.1.

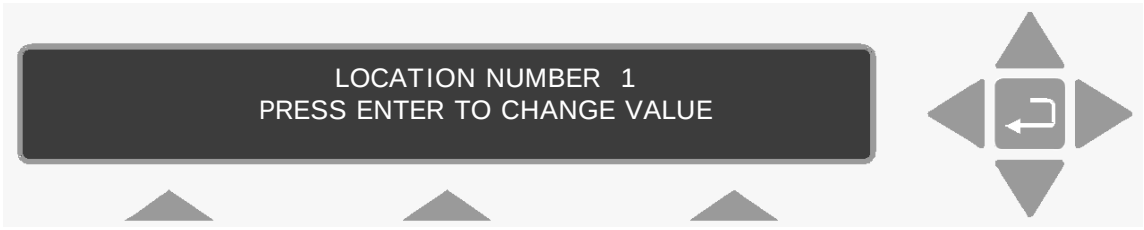
4. Press **S2**. If data has not been stored in the chosen location, a message will appear on the Monitor's display to inform the user. Otherwise, the data from the chosen location in *Background Memory* will be copied into *Display Memory*.

5. Press **MEMORY** to exit.

9.3.3 Deleting Data from Background Memory

To delete data which has been stored in *Background Memory*:

Press **MEMORY** **S3**.



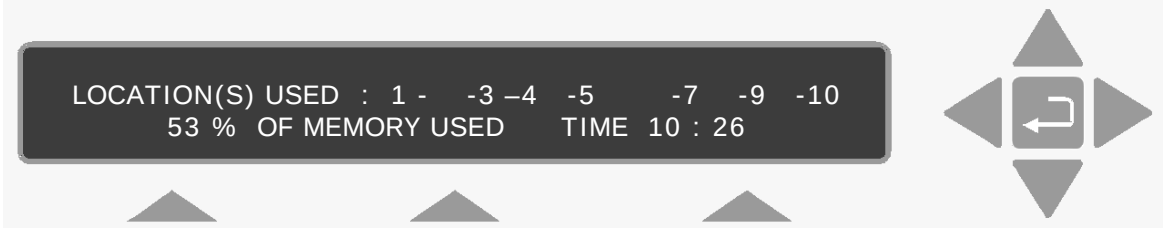
Use the direction keys to select the location number. After selecting the chosen location number the display will show the starting-time of the oldest data stored in the *Background Memory*:

If the starting-time of the oldest stored data to be deleted corresponds with the starting-time shown on the display screen then press **S1** and then **S2** to accept that the data will be deleted from *Background Memory*.

9.3.4 Obtaining Information in Memory Mode

It is not necessary for the user to remember the numbers of the locations in *Background Memory* which have been used to store data. When the Monitor is operated in Memory **mode**, users can at any time find out which locations are used, and what percentage of the *Background Memory's* total data capacity has been used by:

Pressing the **INFO** push-button:



The numbers appearing on the above display are those, which contain stored data. The Monitor will show the above "Information text" display for a short period of time and then automatically change back to the text, which was showing on the display before the **INFO** push-button was pressed

9.3.5 Upload Memory data using the BZ7003 Offline Software.

After recalling data stored in any of the background memories to the display memory see section 9.3.2. The data now stored in the display memory can be uploaded using the BZ7003 Offline Software and stored in excel or text format files. Regarding the use of BZ7003 please refer to the user manual BE6035.

Chapter 10

Using a Printer with the Monitor

April 2015

10.1 Introduction

This chapter informs you on how to obtain hard copies of data stored in the memory of the monitor. This could, for example, be existing calibration data, which you need prior to recalibrating.

For those of you who want to use the monitor as a stand-alone instrument, this chapter enables you to print-out measurement data, error-logs and data-logs. If any error occurs during any of these operations, a warning will be displayed. All possible errors of this kind are listed in Chapter 14.

The Monitor has four interface ports on its back panel, the RS-232, port can be used for printing or the Ethernet port can be used to print to a terminal program like HyperTerminal. This means that any standard text printer with a RS232 interface can be used to print-out data from the Monitor. Data can be printed out while the Monitor is operating – using the **Data-logging** facility. This means that during a monitoring task or during a calibration task the Monitor will automatically send measurement results to the printer as soon as they are available. Any operational errors or warnings that occur during a monitoring task can also be automatically printed out using the **Error-logging** facility. Alternatively, when the Monitor is not being operated in any mode, data can be printed out using the **PRINT** button. Data can be printed out in three different blocks:

1. **Measurement:** this block contains the measurement data displayed on the Monitor screen during the printing operation – it also provides the set-up parameters for the displayed monitoring task (see section 8.2).
2. **Set-Up:** this block contains **active** set-up parameters.
3. **Calibration:** this block contains the optical filter factors, calibration factors and all other information related to the calibration of the optical filters installed in the Monitor.

10.2 Printer Cables

To connect the cables:

1. Ensure that both the Monitor and the printer are switched off at the mains. Failure to do so may result in your equipment being damaged.

2. Locate the desired port at the back of the monitor. The ports are labelled “RS-232”.

3. Push the cable connector on to the correct socket, and secure it firmly using the securing screws.

4. Locate the input port on the printer.

5. Push the connector at the other end of the cable on to this socket, and secure it firmly using the securing screws.

The instruments can be turned on at the mains now.

10.3 Setting-up Communication Parameters

WARNING!: You must perform a **PARTIAL RESET** of the Monitor (press the **RESET** and **S1** buttons) if the **active** value of any parameter in this branch of the Set-Up Tree is changed. If the Monitor is not partially reset, then, the Monitor will not up-date the communication-parameter data which was used last time data was transmitted via either of its interfaces. By performing a partial reset you ensure that the Monitor has the parameters necessary to enable it to transmit data to the attached printer.

Press **SET-UP** **S3** **S1** **S3** and the following text is displayed:

SELECT COMMUNICATION SET-UP BRANCH
RS 232 C ETHERNET CONNECTIONS

If you are using the RS-232 interface, go to section 10.3.1.

10.3.1 RS-232 Interface

A brief description of the communication parameters is given below. A list of the parameters, together with the values available and their factory default values are shown in Table 10.1.

The parameters in this branch decide how the Monitor communicates via the RS232 interface.

SELECT BAUD RATE gives the rate at which data should be transmitted from the Monitor via its RS-232 interface.

SELECT NUMBER OF STOP BITS gives the number of stop bits, which should be used when data is transmitted from the Monitor to other equipment.

SELECT NUMBER OF DATA BITS gives the number of data bits, which should be used when data is transmitted between the Monitor and other equipment.

SELECT PARITY CHECK The user chooses whether or not transmitted data should be checked for transmission errors using the parity checking system.

SELECT HARDWIRE MODE The user chooses which communication line (wire) should be used to control data transmission between the Monitor and other equipment.

SELECT HANDSHAKE TYPE The user chooses which type of "handshake" should be used for transmission via the RS 232 interface.

Table 10.1 The available choices and the default values for each RS-232 communication parameter

Display Text	Acceptable Values	Default Value
SELECT BAUD RATE	300/600/1200/ 2400/4800/9600	9600
SELECT NUMBER OF STOP BITS	1 BIT, 2 BITS	1 BIT
SELECT NUMBER OF DATA BITS	7 BITS, 8 BITS	7 BITS
SELECT PARITY CHECK	NONE, EVEN, ODD	EVEN
SELECT HARDWIRE MODE	Three-wire, Switched-line, Leased-line	Leased-line
SELECT HANDSHAKE TYPE	None, X-ON/X-OFF, Hard-wired	Hard-wired

REMEMBER to partially reset your Monitor if any of the above parameters are changed! See the WARNING at the beginning of section 10.3**.**

From the top of the Communication branch of the Setup Tree

SELECT COMMUNICATION SET-UP BRANCH
RS 232 C ETHERNET CONNECTIONS

1. Press **S1**. (RS 232 C)

2. Use the direction and select push-buttons to select the correct values for the parameters.
   If you are in doubt about any of the settings, refer to your printer manual.

3. When you have been through all the parameters, the monitor returns to the top of the ***Communication*** branch of the Set-Up Tree.

4. Press **S3** **S1** and then **SET-UP**. This selects the RS-232 port as the communication port for the printer.

5. Press **RESET** and **S1** to partially reset your Monitor.

10.3.2 Ethernet Interface

From the top of the Communication branch of the Setup Tree

SELECT COMMUNICATION SET-UP BRANCH
RS 232 C ETHERNET CONNECTIONS

1. Press **S2**. (ETHERNET)

2. Please refer to section 2.5 how to setup the Ethernet parameters.

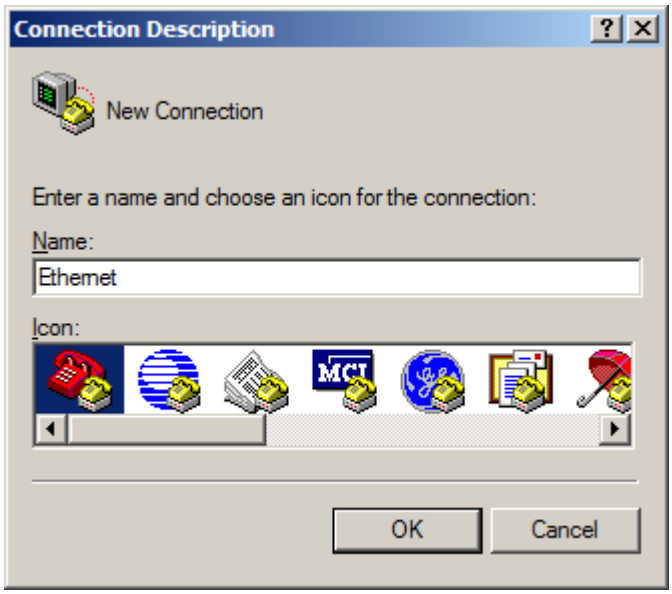
3. When you have been through all the Ethernet parameters, press **SET-UP** and then **S3** **S1** **S3** **S3** **S3** and finally **SET-UP**. This selects the Ethernet port as the communication port for the printer.

Press **RESET** and **S1** to partially reset your Monitor.

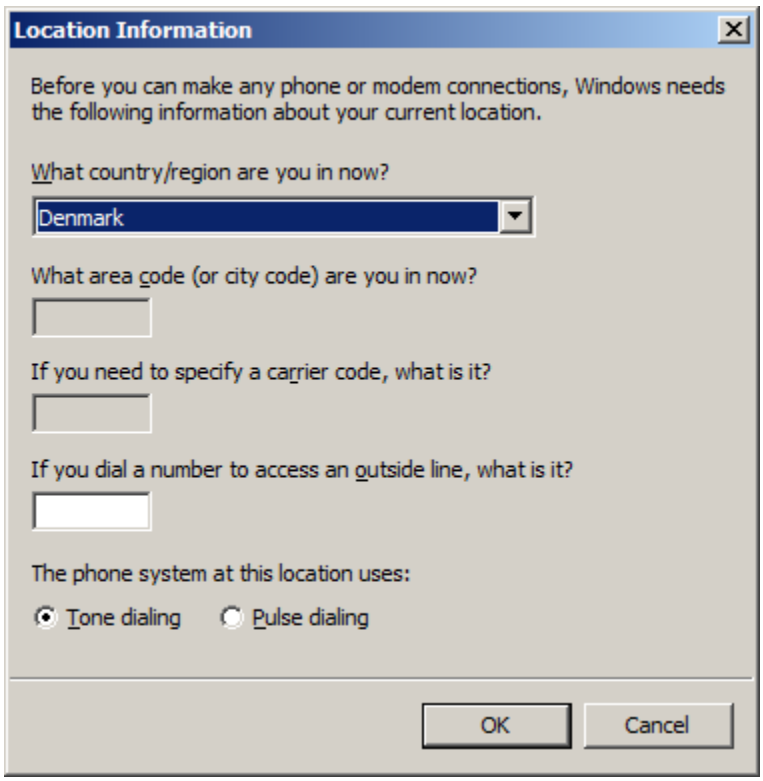
On the remote PC you can now prepare an Ethernet terminal program like HyperTerminal to be able to receive the printed output from the gas monitor.

HyperTerminal is a terminal program able to receive Ethernet communication send from the gas monitor.

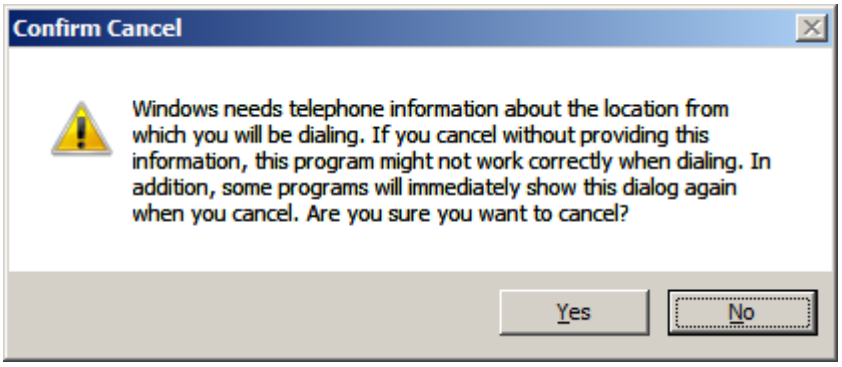
1. After starting the HyperTerminal program please select a name for the connection.



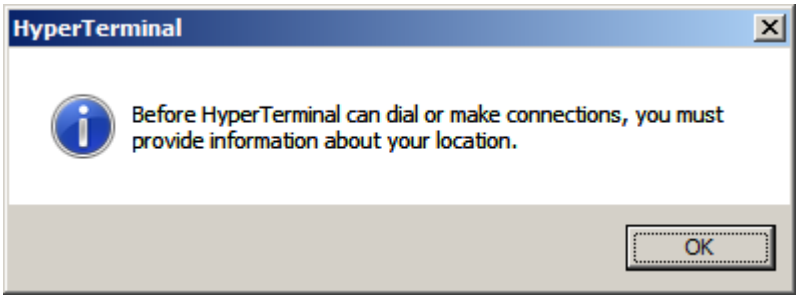
2. Press **OK** to continue.**Error! Reference source not found. Error! Reference source not found. Error! Reference source not found.**


Location Information
Before you can make any phone or modem connections, Windows needs the following information about your current location.
What country/region are you in now?
Denmark
What area code (or city code) are you in now?
If you need to specify a carrier code, what is it?
If you dial a number to access an outside line, what is it?
The phone system at this location uses:
Tone dialing
Pulse dialing
OK
Cancel

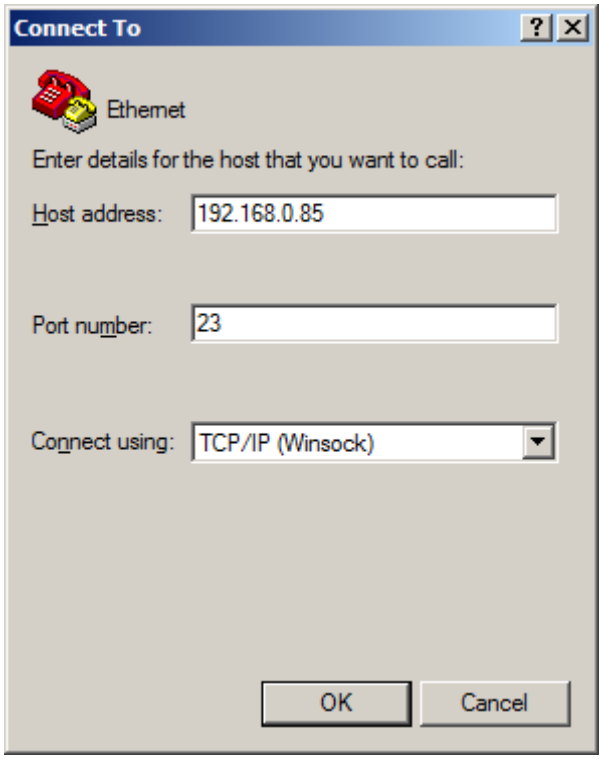
3. Press Cancel to continue.


Confirm Cancel
Windows needs telephone information about the location from which you will be dialing. If you cancel without providing this information, this program might not work correctly when dialing. In addition, some programs will immediately show this dialog again when you cancel. Are you sure you want to cancel?
Yes
No

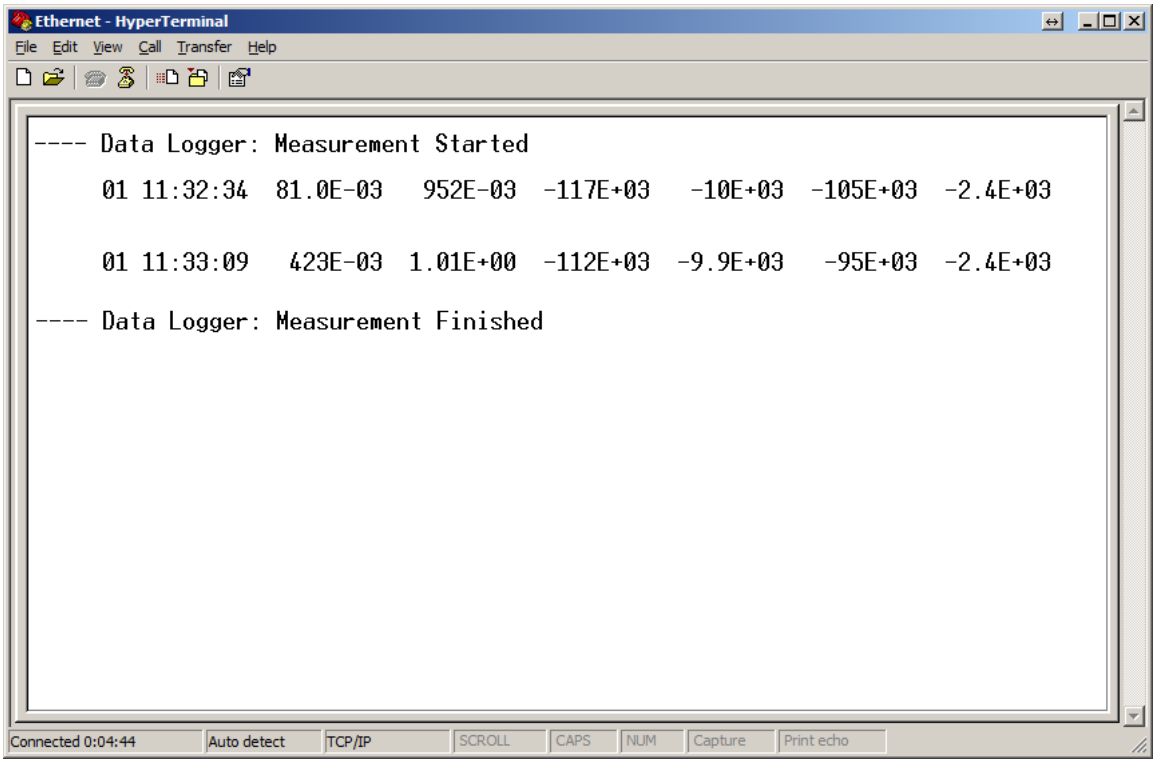
4. Press **Yes** to continue.


HyperTerminal
Before HyperTerminal can dial or make connections, you must provide information about your location.
OK

5. Press **OK** to continue. Connect using 'TCP/IP (Winsock)' and enter the IP Address of the gas monitor as the 'Host address'. Press **OK** to continue.



6. You are now able receive printed output from the gas monitor in the terminal window that you have just created. Below is shown a measuring task session.



10.4 Additional Parameters Required

The other output parameters which determine the format of print-outs are shown in Table 10.2 together with available choices and factory default values.

Table 10.2 Parameters which determine the format of print-outs from the monitor

Display Text	Acceptable Values	Default Value
PRINT EACH GAS?	No, Yes	Yes
(if print each gas is no) PRINT GAS N*?and/or Air Pressure	No, Yes	No
SELECT TEXT LINE TERMINATOR	CR, LF, CR-LF	CR-LF

If one chooses to **PRINT EACH GAS**, then all gases, which have been measured, will be printed out. If one does not choose to **PRINT EACH GAS** then the user is given the chance to choose which of the gases A and water (W) should be printed out – **PRINT GAS A?** and so on.

SELECT TEXT LINE TERMINATOR The user chooses which character the Monitor should use as “end of text line” when data is transmitted from the Monitor.

10.5 Data Logging Function

Setting-up the Monitor to Print a Data Log

If the Monitor is connected up to a printer, and it is set-up to transmit data to the printer, this function enables measurement data to be printed out, automatically, as soon as it becomes available during a measurement or calibration.

The procedure is as follows:

1 Press the following sequence: **SET-UP** **S3** **S1** **S1**, and the following text is displayed:

SELECT GENERAL SET-UP BRANCH ?		
CLOCK	SOUND	TESTS

2 Press **S3** ▼ **S3** **SET-UP**. This activates the data logging function.

10.6 Error Logging Function

Setting-up the Monitor to Print an Error Log

If the Monitor is connected up to a printer, and it is set-up to transmit data to the printer, this function enables any warning or error messages that are displayed, to be recorded in the printed error log, automatically.

The procedure is as follows:

1. Press the following sequence: **SET-UP** **S3** **S1** **S1**, and the following text is displayed:

SELECT GENERAL SET-UP BRANCH ?		
CLOCK	SOUND	TESTS

2. Press **S3** ▼ ▼ **S3** **SET-UP**. This activates the error logging function.

10.7 Printing-out Data from the Monitor

Before data can be printed out from the Monitor, the communication parameters must be checked/changed. This is explained in section 10.3.1 for RS-232 communication and in section 10.3.2 for the Ethernet communication. The text line terminator must be set (see section 10.4) before printing can proceed.

It is also necessary to define the averaging period if the **AVERAGE** option is selected. Setting the Data Logging function is described in section 10.5.

10.7.1 Starting a Print-out

Press **PRINT** and then one of select push-buttons **S1** **S2** or **S3** depending on which data block you wish to print-out.

10.7.2 Stopping a Print-out which is in Progress

If a print-out is in progress and you wish to stop it, then the following steps need to be followed:

1. Press the **PRINT** button on the Monitor's front panel.
   The following text will appear on the display:

PRINT ABORTING PLEASE WAIT

   The printer will stop printing data.

2. Use the Line Feed function on the printer if the paper is not ejected automatically.

Chapter 11

Maintenance of the 3436i

April 2015

The only regular maintenance required for the 3436i is:

Calibration – approximately every 3 months (see Chapter 12).
Changing the fine air-filter paper in the internal and external air-filtration units (see section 11.1).
Cleaning of the filter in the ventilation unit (see section 11.2).

11.1 Changing the Fine Air-filters

The monitor is equipped with an ***internal*** filtration unit.

The ***internal*** unit is mounted on the air-inlet, on the back panel. This is shown in Fig.11.1.

Fig.11.1 The internal air-filtration unit mounted on the back panel of the monitor.

The internal air-filtration unit can be removed simply by unscrewing the unit by hand. The unit is shown in Fig.11.2.

Fig.11.2 The internal air-filtration unit

Inside the unit, a fine (10µm) filter-paper removes fine dust particles and other suspended matter from air samples before they reach the measurement chamber of the Monitor.

Whenever the Monitor needs to be calibrated, we recommend that the fine filter-paper in the internal air-filtration unit is changed **before** you calibrate. The fine filter-paper in the internal air-filtration unit must be changed at least twice a year; and more frequently if the environment in which the monitor is working contains large quantities of particulate material suspended in the air.

When the monitor is making measurements, we recommend that a length of Teflon® tubing (of up to 50 metres in length) is always attached to the stub of the air-inlet (see Fig.11.1) and that the special *external* air-filtration unit UD 5023 (optional accessory), shown in Fig.11.3, is always attached to the free-end of the sampling tube, by means of the small stub. An external coarse metal air-filter prevents large particles, insects etc. being drawn into the unit, while inside the unit is a fine (10µm) filter-paper, which prevents any finer particles from entering the Teflon® sampling tube. The fine filter-paper in this unit must **also** be changed regularly – at least as frequently as the fine filter-paper in the internal fine air-filter.

Fig.11.3 The external air-filtration unit UD5023 used with the Monitor, (optional accessory)

Changing the fine filter-paper in both the internal and external air-filtration units is explained step by step in the following two sub-sections.

11.1.1 Changing the Filter-paper in the Internal Air-filtration Unit

While you do this, we recommend that you wear clean, rubber gloves.

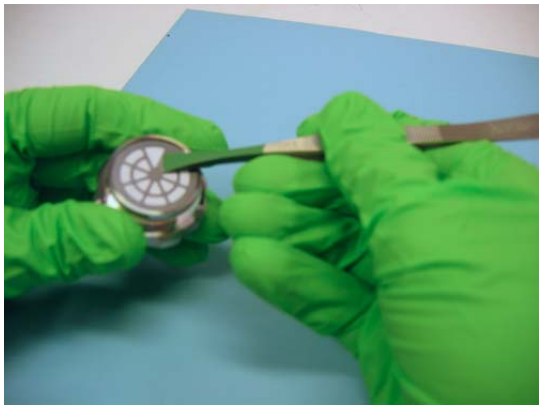
Tools and equipment required:

Acetone (analytically pure)
Spare fine filter-paper DS 0759
Tweezers with Teflon coating
Cotton buds
Clean rubber gloves

To change the filter-paper:

Switch the power to the monitor “Off” by using the AC mains power switch on its back panel (press O), and then pull out the plug connecting the monitor to the AC mains power supply.
Put a rubber glove on the hand, which is to hold the parts of the unit.
Unscrew the internal air-filtration unit from its mounting on the air-inlet, see Fig.11.1. To do this, turn the unit anti-clockwise with your fingers until the unit is free of the slot.
The unit is removed from the monitor. It is shown in Fig.11.2.
Use the tweezers to lift off the retaining disc and used filter-paper, while holding the handle of the unit between your thumb and fingers. Refer to Fig.11.4. The retaining disc has two tabs which “lock” it to the filtration unit.

Fig.11.4 Removing the retaining disc and old filter-paper



Holding the disc with the tweezers, moisten a cotton bud with pure acetone and use it to clean the surfaces of the disc. Place the disc on a clean, dry surface.
Caution: Make sure that no cotton fibres remain on the mesh of the retaining disc otherwise they could be sucked up into, and block the measurement system when the Monitor is operated.
Hold the handle-end of the unit between your thumb and fingers. Moisten a cotton bud with pure acetone and use it to clean the surfaces of the unit. Refer to Fig.11.5. Place the unit, with its handle-end downwards, on a clean, dry surface.

Fig.11.5 Cleaning the surfaces of the internal air-filtration unit

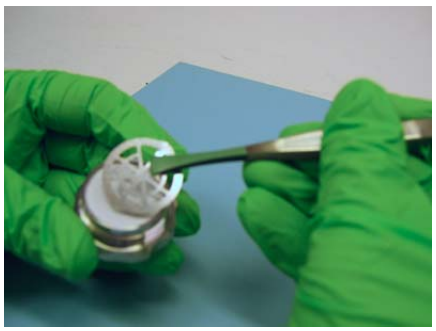
Notes:
Only proceed to the next step when the acetone has completely evaporated from the air-filter retaining disc and filtration unit.
Each of the fine filter-papers DS 0759 are packed between two pieces of packing paper. The fine filter-paper is always white in colour.

Remove a new fine filter-paper from its packaging using the tweezers. Hold it by its edge. Refer to Fig.11.6. Lift the filter up and place it inside the unit.

Fig.11.6 Placing a new filter-paper in the unit

Holding the handle-end of the unit between your thumb and fingers, pick up the (dry) retaining disc and place it over the new filter-paper. Refer to Fig.11.7. Gently press the disc down over the filter-paper, making sure that the disc's locking tabs fit properly into the groove in the unit and that the filter-paper stays in position and is not damaged in any way.
Holding the handle-end of the re-assembled unit between your thumb and fingers, place it back into position in the air-inlet of the Monitor. Screw it back into its mounting. To do this, turn the unit clockwise with your fingers to tighten until it is in position.

Fig.11.7 Refitting the retaining disc



11.1.2 Changing the Filter-paper in the External Air-filtration Unit

While you do this, we recommend that you wear clean, rubber gloves.

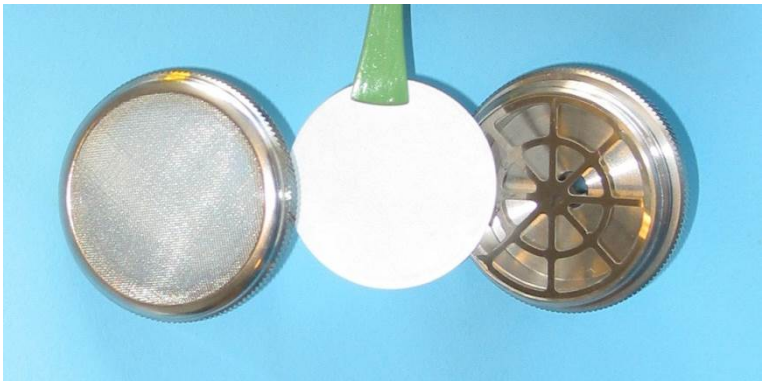
Tools and equipment required:

Acetone (analytically pure)
Spare fine filter-paper DS 0759
Tweezers with Teflon coating
Cotton buds
Clean rubber gloves

To change the filter-paper:

Switch off the Monitor.
Put a rubber glove on the hand which is to hold the parts of the unit.
Pull the external fine air-filtration unit off the end of the Teflon® sampling tube. Hold the stub-end of the external air-filter unit between your thumb and fingers, and unscrew the coarse air filter from the end of the unit. Refer to Fig.11.3.
Remove the used (old) filter-paper and the retaining disc from the unit using the tweezers. Refer to Fig.11.8.

Fig.11.8 The parts of the external air-filtration unit UD 5023



Moisten a cotton bud with pure acetone and use it to clean the surfaces of the unit, the retaining disc and the coarse air-filter. Refer to Fig.11.8. Place the stub-end of the unit downwards, on a clean, dry surface; the coarse air-filter, with its screw-end downwards on a clean, dry surface and rest the retaining disc against it.

Caution: Make sure that no cotton fibres remain on the mesh of the retaining disc otherwise they could be sucked up into, and block the measurement system when the analyzer is operated.

Notes:
Only proceed to the next step when the acetone has completely evaporated from the cleaned surfaces.
Each of the fine filter-papers DS 0759 are packed between two pieces of packing paper. The fine filter-paper is always white in colour.

Hold the stub-end of the unit between your thumb and fingers. Lift the retaining disc with the tweezers and place it back into position in the unit. Refer to Fig.11.8.
Remove a new fine filter-paper from its packaging using the tweezers. Hold it by its edge. Carefully place the filter-paper over the top of the retaining disc so that it is held in position by the small “lip” on the rim of the unit.
Screw the coarse air-filter over the end of the external air-filtration unit. Make sure that the fine filter-paper remains in its correct position directly over the retaining disc.

11.2 Cleaning the Filter in the Ventilation Unit

A small ventilation unit is mounted on the back panel of the Monitor (see in Fig.11.9). The ventilating fan in this unit circulates air through the Monitor to keep it cool. To ensure that the air being drawn into the Monitor is free of particles a filter pad is placed between the fan and grid which covers it. This filter needs to be periodically taken out and cleaned. We recommend that this task is done at least as often as calibration, and more frequently if the Monitor is working in a very dusty atmosphere or an atmosphere containing high concentrations of other particulate matter.

Use a “pozidrive” screwdriver to unscrew the screw on the grid cover. Remove the filter pad from inside the grid cover. Wash the filter pad in warm water containing some liquid soap. Rinse all the soap out of the filter, by running clean water through it, and let it dry **thoroughly**.
Place the clean, thoroughly dry, filter pad inside the grid cover. Screw the grid cover firmly back in place over the ventilation unit.

Fig.11.9 Back panel of the 3436i showing the ventilation unit

11.3 Cleaning the Instrument

It is recommended to clean the instrument using a damped cloth.

Chapter 12

Calibration of the Optical Filters

April 2015

12.1 About the Installed Optical Filters

The optical filter UA0936 has been installed in the position marked “A” of the filter carousel wheel in your Monitor. A special optical filter, which is selective to water vapour, is always installed in position “W”.

The optical filter has to be **span calibrated** with the gas it is to measure. If this **span calibration** is not performed the Monitor is unable to measure accurately.

Each filter in the carousel has to be **fully** calibrated before the Monitor can perform accurate gas measurements. The practical calibration procedure is fairly simple, it involves performing measurements with the Monitor while various gas supplies are attached to its air-inlet.

A **full** calibration of the water-vapour filter SB 0527 involves:

- **Zero-point calibration** (using a zero-gas*)
- **Span calibration** (using a known concentration of water vapour)

A **full** calibration of the optical filter in position “A” involves:

- **Zero-point calibration** (using a zero-gas*)
- **Humidity-interference calibration** (using water-vapour)
- **Span calibration** (using a known concentration of the gas (SF6) this filter is to measure)

The following sections explain what a calibration is and why it is necessary. Some of the expressions used in this chapter are also explained, to help you understand the process.

* A zero-gas is a gas which does not absorb infra-red light e.g. pure Nitrogen.

12.2 What is Calibration and Why is it Necessary?

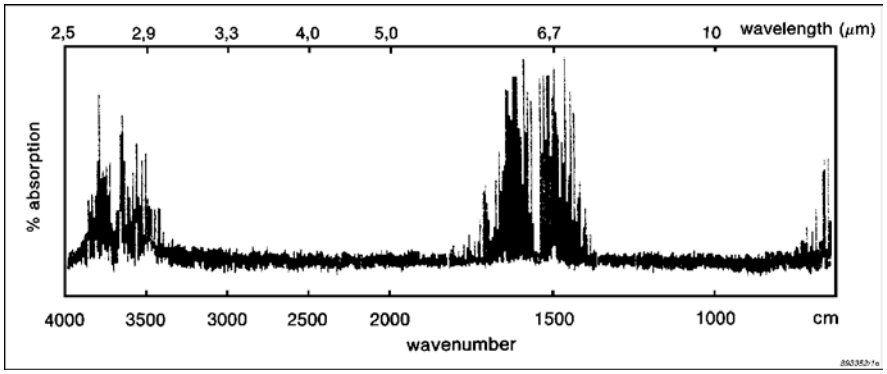
In order to understand calibration, it is necessary to look at what happens inside the analysis cell during a gas concentration measurement. A sample of air is drawn into the cell. The cell is then sealed off and light is sent from the infra-red source via a chopper (to pulsate it) through an optical filter. The optical filter only transmits light in a defined wavelength range and this light enters the cell.

If there is a gas in the cell, which absorbs light of this wavelength, a pressure wave is created and this is measured by the microphones mounted within the cell. The greater the concentration of the absorbing gas in the cell, the greater the pressure (sound) wave it creates.

How do we measure the relationship between the measured sound signal and the concentration of the absorbing gas in the cell? We calibrate the optical filter.

Our description of what happens in the cell is, however, a little too simplified. In reality, we have to take three other factors into consideration: namely: (1) cell noise; (2) the presence of water vapour in the sample (humidity interference).

Fig.12.1 High resolution absorption spectrum of water vapour



Cell Noise

When there is zero-gas in the cell (that is, a gas which does not absorb any infra-red light) a signal is measured in the cell. This signal is due to what is termed **cell noise**. Cell noise is created by the imperfect reflection of infra-red light from the cell walls. It is dependent upon the properties of the cell itself (for example, its dimensions and the reflectivity of its walls) as well as the wavelength (and thus energy) of the infra-red light which is incident on its walls.

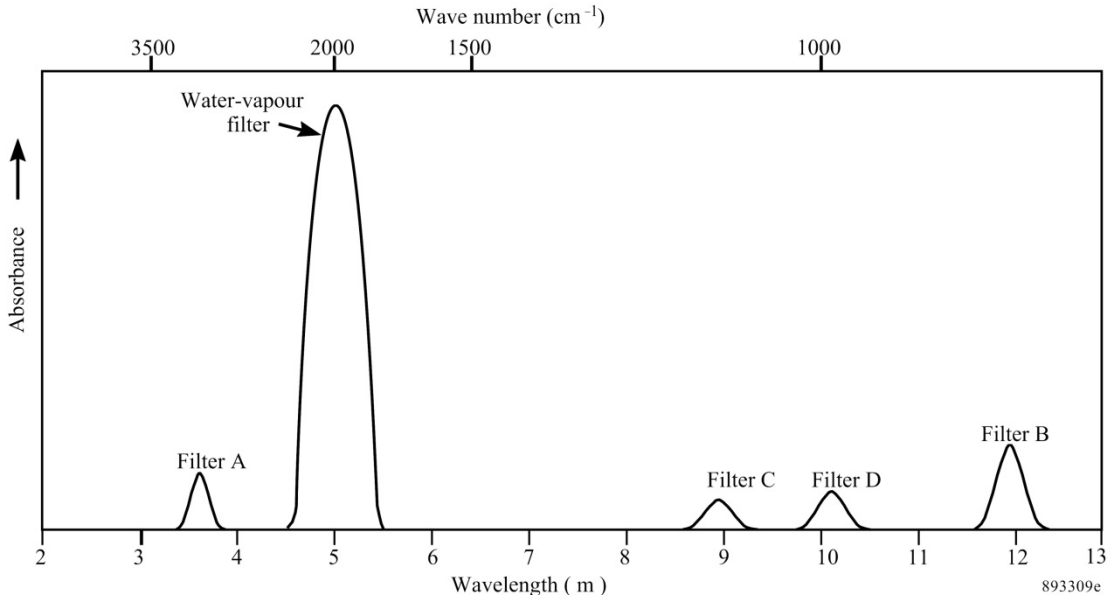
As it is the optical filter, which determines the wavelength of light, cell noise will depend upon the optical filter being used.

The cell-noise signal is measured during the **Zero-point Calibration** of each filter. A supply of dry, zero gas is attached to the air-inlet of the Monitor and the signal in the cell is measured with the installed optical filter ("A"). This signal is called the **concentration offset factor** for the filter. Whenever the filter is used, this signal is subtracted from the total measured signal as it is not related to the concentration of any gas.

Presence of Water Vapour

Water vapour is nearly always present in ambient air and it absorbs infra-red light, to a greater or lesser extent, at nearly all wavelengths (see Fig.12.1). This means that no matter which optical filter is transmitting light into the cell the water vapour in the cell will absorb some of this light and create a signal. This signal is said to "interfere" with the signal produced by the gas we wish to measure with this filter.

Fig.12.2 Schematic diagram showing the relative absorption of water vapour by different optical filters



How is this interference measured? A water-vapour optical filter, which transmits light with a wavelength, which is absorbed by very few gases, except water vapour, is always installed in position "W" of the filter carousel. Using this filter, water-vapour's interference is measured during the **Humidity Interference Calibration** on the installed filter. A supply of zero gas containing a constant concentration of water vapour is attached to the air-inlet of the

Monitor. The signal in the cell is measured with the water vapour filter and with the installed optical filters.

The water vapour in the cell absorbs light from the water-vapour filter and from the installed filter, producing signals which are related to water-vapour's relative absorption of the light at the wavelengths transmitted by the optical filter (see Fig.12.2). We know, however, that the ratio of the signal measured with any one filter (e.g. "A") and the signal measured with the water-vapour filter is a constant. This ratio is related to the **Humidity Gain Factor** calculated during the humidity-interference calibration of filter "A". For example, if the signal produced by water vapour when using the water-vapour filter, is 160µV and using Filter "A" is 16µV, then, if the signal measured with the water-vapour filter is found to be 80µV, we know that this concentration of water vapour will produce a signal of 8µV when Filter "A" is used. Measurements made during humidity-interference calibration of the installed filters therefore enable the Monitor to compensate any measured signal for water-vapour's interference.

12.3 Tasks Before Starting Any Calibration

Before starting any kind of calibration task there are several operations, which need to be performed:

12.3.1 Obtaining a Print-out of Calibration Data in the Monitor

Whether the Monitor is to be used online or as a stand-alone instrument, the Calibration Software BZ7002 can be used to check the Monitor's existing calibration. Please refer to User manual BE6034.

Stand-alone Use

With the monitor connected to a printer (details are given in Chapter 10):

Press **PRINT** and then **S3**.

To stop printing, press **PRINT** again.

12.3.2 Checking the Calibration of Each Installed Optical Filter

A print-out of the calibration data in the Monitor's memory is useful to have for reference. It also enables you to find out how "old"

calibration factors compare with the “new” calibration factors calculated during re-calibration tasks, see section 12.3.1.

Fig.12.3 illustrates only part of a typical calibration data print-out. Note that there are **five** different filter banks, which contain calibration data. These banks are numbered from 1 to 5. This enables each filter to be calibrated to measure up to 5 different gases. Before the filter is calibrated to measure any one particular gas, you have to inform the Monitor about where you wish to store the calibration data for this gas. The number of the filter bank chosen when operating in **Set-Up mode** is called the **active** filter bank (see Chapter 9).

When checking the optical filter using the front panel push-buttons, Chapter 10 provides details of how to obtain a print-out of calibration data using a printer with an RS 232 interface.

Note that calibration data in the active filter bank is always printed out directly after the optical filter factors data and this data is also shown under the **heading CALIBRATION DATA IN FILTER BANK : X**, where X is the number of the filter bank.

Note: all calibration factors are expressed as exponential numbers. For example: 104.05E-3, this is the same as the number 104.05 x 10-3 = 0.10405

1. Refer to your calibration data print-out and check the following information:

   a. Under the **heading GENERAL CALIBRATION INFORMATION FOR FILTER A:** check that the UA number of the installed optical filter is UA0936 the same as the UA number appearing on the “Calibration Chart” for the optical filter in position “A”.

      Under the headings **CALIBRATION DATA IN FILTER BANK:1**; **CALIBRATION DATA IN FILTER BANK:2**; **CALIBRATION DATA IN FILTER BANK:3**; **CALIBRATION DATA IN FILTER BANK:4**; and **CALIBRATION DATA IN FILTER BANK:5** check the following information:

   b. **Zero-point calibration performed:** if a date appears here (**year-month-day**) this is the last time the zero-point calibration data in this filter bank was updated.

   c. **Concentration offset factor:** if a number appears here this means that this filter bank contains calibration data obtained during a zero-point calibration of filter “A”.

   d. **Hum. Interference Calibration performed:** if a date appears here (**year-month-day**) this is the last time the

humidity-interference calibration data in this filter bank was updated.

e. **Humidity gain factor:** if a number appears here this means that this filter bank contains calibration data obtained during the humidity-interference calibration of filter “A”.

f. If the following three conditions are found in any filter bank:
   - **Gas name:** if the name which appears here is the same as the name of the gas you intend to measure with filter “A”;
   - **Span Calibration performed:** if a date appears here; and
   - **Conversion factor:** a number appears here;

   Then this filter has been properly span calibrated with the named gas. The **filter bank** containing this calibration data is the filter bank, which has to be made **active** when filter “A” is to measure this named gas.

g. However, if the **Gas name:** is given as “Gas UA number” then the filter has only been checked to see that it is functioning correctly, it has **not** been **span calibrated** to measure the gas you wish to measure.

2. Under the heading **GENERAL INFORMATION FOR WATER FILTER – ACTIVE CALIBRATION DATA :** check the following information:

   a. **Zero-point Calibration performed:** if a date appears here this is the last time the water-vapour filter was zero-point calibrated.

   b. **Concentration offset factor:** if a number appears here this means that the water-vapour filter has been zero-point calibrated.

   c. **Span Calibration performed:** if a date (**year-month-day**) appears here, this is the last time span calibration of the water-vapour filter was performed.

   d. **Conversion Factor:** if a number appears here this means that the water-vapour filter has been span calibrated.

When the water-vapour filter has been zero-point calibrated **and** span calibrated it is able to measure the absolute concentration of water vapour in any gas sample in the analysis cell of the Monitor, and it requires **no** further calibration.

When the installed optical filter has been zero-point, humidity-interference and span calibrated then the Monitor is able to perform accurate measurements.

Fig.12.3 Part of a calibration data print-out

```
- 3436i Calibration Data ------- 620-002/9441 - 2015-01-18 09:31 - Page  1 -


GENERAL CALIBRATION INFORMATION FOR FILTER A.
-------------------------------------------------------------------------

Installed Optical Filter                :          UA0936
Active Filter Bank Number               :               1


OPTICAL FILTER FACTORS
-------------------------------------------------------------------------
Back. temp. factor                      :      1.1847E-03
Conc. temp. factor                      :      4.7101E-03
Hum. temp. 1 factor                     :      -3.819E-03
Hum. temp. 2 factor                     :      -27.00E-03
Hum. temp. 3 factor                     :      0.0000E+00
Hum. sqr. factor                        :      3.8020E+03
Hum. cub. factor                        :      0.0000E+00


ACTIVE CALIBRATION DATA
-------------------------------------------------------------------------
Gas name : SF6
Molecular weight                        :      146.05E+00
High Alarm Limit 1                      :         _______ ppm
High Alarm Limit 2                      :         _______ ppm

Span Calibration performed              :      2015-01-18
Type of Span Calibration                :    Single Point
Conversion factor                       :      105.71E+03
Concentration                           :            90.2 mg/m3
Microphone Signal                       :             785 uV

Zero-Point Calibration performed        :      2015-01-18
Concentration offset factor             :      3.9163E-06
Microphone Signal                       :            3.98 uV

Hum. Interference Calibration performed :      2015-01-18
Humidity gain factor                    :      9.9367E-03
Microphone Signal                       :            6.90 uV

Cross Interference Calibration performed :      _________
SF6 interference on :
Filter B                                :      _________
Filter C                                :      _________
Filter D                                :      _________
Filter E                                :      _________
```

12.3.3 Checking and Changing Optical Filter Parameters

Before starting calibration it is always wise to check that information about the installed optical filter has been “entered” **correctly** in the **active** set-up of the Monitor. If the **incorrect** UA number is “entered” for the optical filter, the incorrect optical filter factors will be used in the calculation of the calibration factors, and calibration will therefore be useless.

The UA number can only be changed using the push-buttons on the front panel of the monitor.

1. Press **SET-UP** **S3** **S3**.
   The following text appears on the screen display:

CHECK AND / OR CHANGE SET-UP FOR FILTER A
NO YES

2. Press **S3** and the following text appears on the screen display:

SELECT UA NUMBER FOR FILTER A 0988
PRESS ENTER TO CHANGE VALUE

   The UA number of the filter installed in position "A" should have already been checked (see section 12.3.2).
   WARNING! If this number is changed all calibration data for this filter – in all 5 filter banks – will be deleted (i.e. lost) and the filter will have to be fully calibrated again before it can be used.
   If the incorrect filter is selected, press ↵ and use ▲ and ▼ to scroll through the UA numbers, until the correct UA number is displayed.

The procedure divides here. PC users go to step 3. and Stand-alone users go to step 4.

3. Only the Filter UA number need to be checked/changed using the monitor's push-buttons. All the other parameters are set when setting up the calibration using the Calibration program.
   Then exit the Calibration Set-up by pressing **SET-UP**.

4. Press ↵.
   The following text appears on the screen:

FILTER BANK NUMBER 1
PRESS ENTER TO CHANGE VALUE

5. Press ↵, and use ▲ and ▼ to display the number of the filter bank (1-5) where you wish the Monitor to store the calibration factors calculated during the span calibration of this filter using this particular gas.

6. Press ↵.
   The following text appears on the screen:

GAS A IS "_ "
PRESS ENTER TO CHANGE VALUE

7. Press ↵ and use the direction push-buttons to enter the desired name.

8. Press ↵ to "accept" the name you have "entered" on the display screen. The following text then appears:

MOLECULAR WEIGHT OF GAS A 1.000
PRESS ENTER TO CHANGE VALUE

9. Press ↵ and use the direction push-buttons to "enter" the molecular weight of the gas to be measured by filter A.

10. Press ↵ to "accept" the molecular weight you have "entered" on the display screen. The following text appears on the screen:

FILTER A SAMPLE INTEGRATION TIME 5 s
PRESS ENTER TO CHANGE VALUE

11. Press ↵, and use ▲ and ▼ to display the desired Sample Integration Time.
    There are seven to choose from: 0.5s, 1s, 2s, 5s, 10s, 20s and 50s.

12. Press ↵ to "accept" the selected value.
    The following text appears on the screen:

GAS A HIGH ALARM LIMIT 1 _____mg/m³
PRESS ENTER TO CHANGE VALUE

13. Press ↵ and use the direction push-buttons to enter the desired alarm level.

14. Press ↵ to accept the entered value. Following screen is displayed:

GAS A HIGH ALARM LIMIT 2 _____mg/m³
PRESS ENTER TO CHANGE VALUE

15. Repeat step 13 and 14 to enter the desired alarm level.

16. All the parameters for Filter W are fixed except for the Sample Integration Time and the two high Alarm limits.

17. Press ↵ and use ▲ and ▼ to display the desired Sample Integration Time.

18. Repeat step 13 and 14 to enter the desired alarm levels.

19. Press ↵, this returns you to the top of the Configuration Set-up Tree.

12.3.4 Setting-up the Monitor to Print a Data Log

This is only necessary for those of you who do not use the Calibration Software BZ7002 to calibrate the Monitor.

During calibration, the calibration gas is drawn into the cell and the microphones measure the signal produced by the gas's absorption of light from the infra-red light source. As soon as a measurement is made it is displayed on the Monitor's screen. Measurement results are constantly updated on the display, but only one set of measurement results are displayed at a time, and no scrolling facility is available to look at previously-displayed results. Therefore, your Monitor should be set-up to print a "Data log" This is described fully in section 10.5.

12.3.5 Warming Up the Monitor

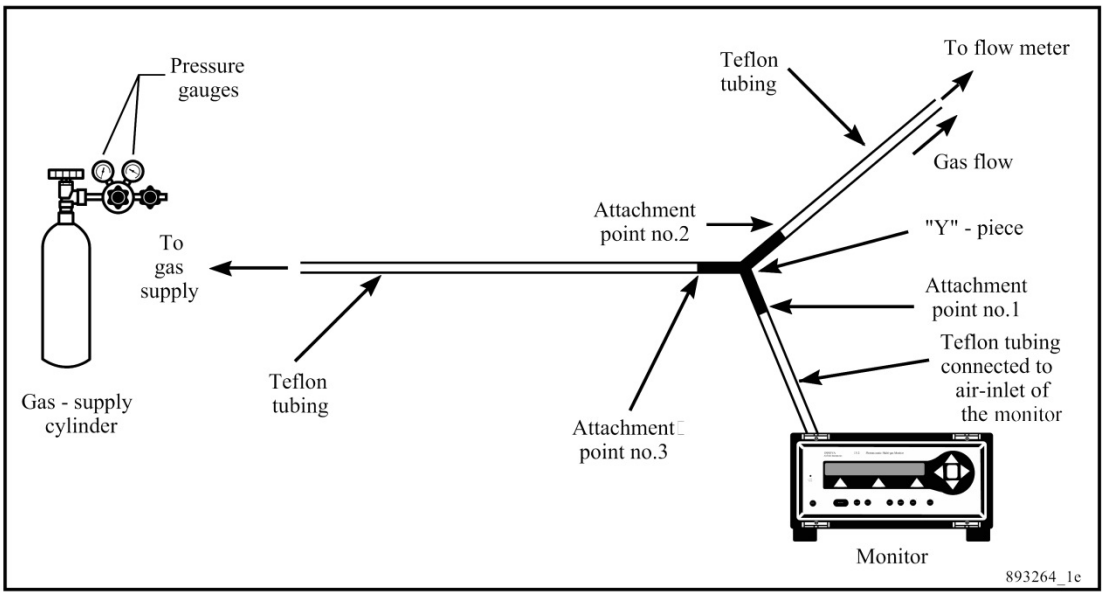
The infra-red light source is very hot and the temperature in the analysis cell thus increases as calibration measurements proceed. Conditions within the cell tend to stabilise more quickly once the temperature inside the analysis cell is 15°C above the ambient room temperature. We therefore suggest that you set-up the Monitor to sample continuously, for a period of 30 – 40 min. to warm up the analysis cell before a calibration task is started. This will reduce the time required for calibration.

To warm-up the Monitor you need to set-up a monitoring task and make the Monitor perform the task for a period of time. If you are unsure about setting up and starting a monitoring task, full instructions are provided together with an example in section 4.3 for stand-alone use.
The Continuous warm function can also be used hence the warm up starts on power on. (see section 5.6).

12.4 The Basic Calibration Set-up

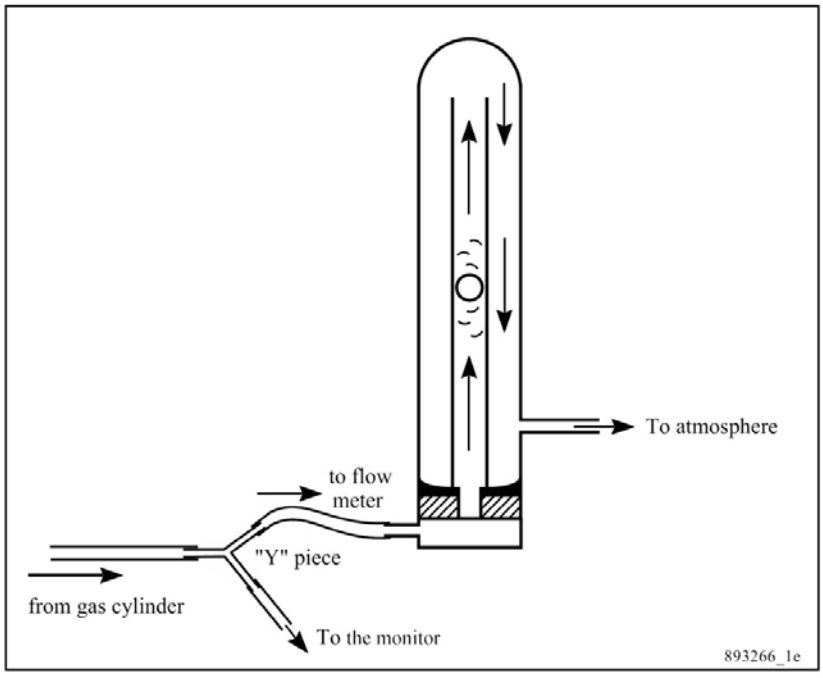
The general equipment required to perform the calibration is shown in Fig.12.4. Three different lengths of Teflon tubing are connected to a “Y”-piece. The tube attached to point 1 is connected to the air-inlet of the Monitor; the tube attached to point 2 is attached to a gas flow meter or similar apparatus; and the tube attached to point 3 is attached to the cylinder of gas which is to be used during calibration.

Fig.12.4 General equipment required for a calibration task



Attaching a gas flow meter serves two vital functions (see Fig.12.5):

Fig.12.5 Schematic diagram of a flow meter



- It allows you to have a visually check that there is a net flow of gas **out** of the Teflon tube attached to it during the whole calibration procedure. The “flow ball” can be seen to be bouncing on the upward flow of air out of the meter.
  If the pressure of the gas from the cylinder is too low at any time then the “flow ball” will just remain seated at the bottom of its tube. This condition must be avoided because atmospheric air will be drawn into the Teflon tube system via the flow meter and cause dilution of the calibration gas. This will affect the accuracy of your calibration.

- It functions as an **escape valve**. When the pressure of the gas in the tubing becomes greater than atmospheric pressure, gas flows out to the atmosphere via the flow meter. This ensures that the gas entering the analysis cell is as close to atmospheric pressure as possible, and this prevents damage to the very sensitive microphones in the analysis cell.

WARNING!: The analysis cell of the monitor is equipped with sensitive microphones, and therefore NO direct connection between the Monitor’s air-inlet and the pressure-valve on a gas cylinder is allowed. Under NO circumstances should the pressure of the air in the analysis cell be allowed to exceed 0.1 bar above the ambient pressure.

1. Attach the Teflon tubing to the Air Inlet Filter at the back of the monitor. This is described in detail in section 4.2.

2.
   a. Connect the free-end of the length of tubing attached to the air-inlet to one of the branches of the “Y”-piece (see attachment point no. 1 in Fig.12.4).
   b. Cut off another 1m length of Teflon tubing and connect one of its ends to attachment point no. 2 of the “Y”-piece (see Fig.12.4) and its other end to a flow-meter.

3. Connect a 1m length of tubing to attachment point no. 3 of the “Y”-piece (see Fig.12.4).

12.4.1 Producing a Supply of Clean, Wet Air

When humidity-interference calibrations are performed, clean, wet air is required. This can be produced in the following manner.

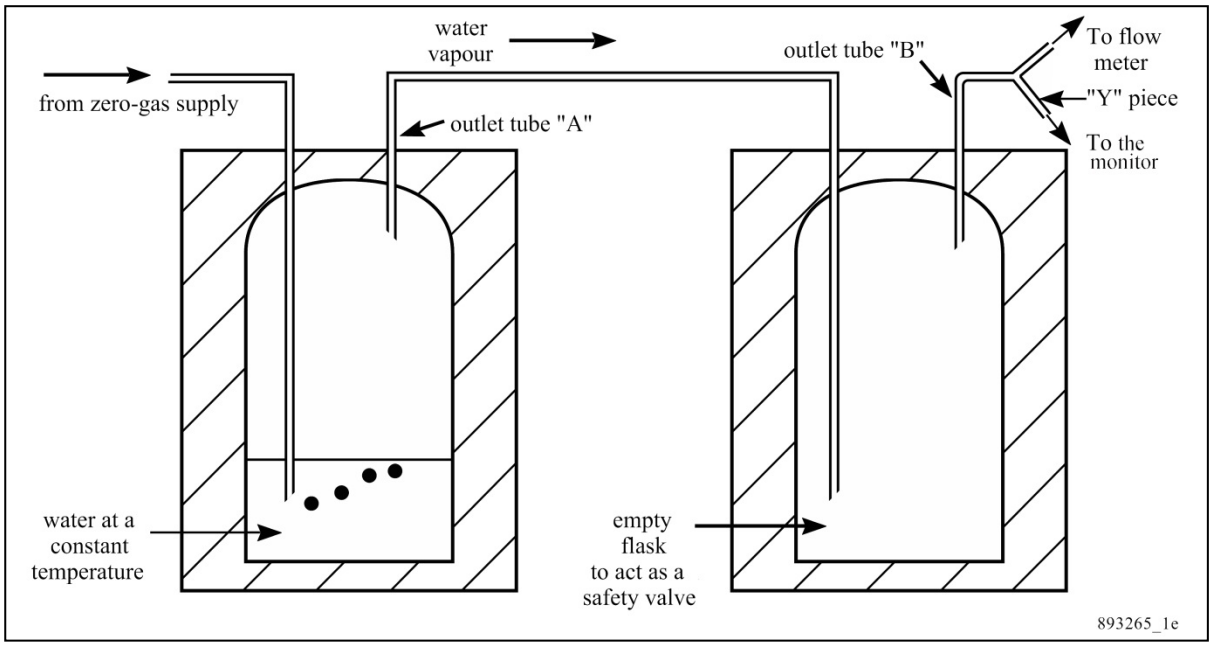
We suggest that you bubble zero-gas (e.g. pure nitrogen) through a thermostatically-controlled water-bath to produce a supply of clean, wet air to the Monitor during humidity-interference calibration of the filters (see Fig. 12.6). Notice that the thermostatically-controlled

water bath is linked up to an extra “empty” flask. This is to prevent a situation where the level of water in the controlled water-bath rises and covers the outlet tube “A” and draws water, via the “Y”-piece, directly into the Monitor’s analysis cell. Water will seriously damage the cell. To avoid such a situation, we suggest that the wet air from the water-bath outlet tube is fed into an extra empty flask before being fed to the air-inlet of the Monitor. Note the length of the respective tubes in the flasks. It is **vitally important** that any water, which collects in the extra flask, does not cover the short outlet tube “B”.

It is very important that the concentration of water vapour used is below the **saturated** water-vapour pressure of the air in the room where calibration is being performed, otherwise water vapour will condense out in the analysis cell. In practical terms this means that:

- The Monitor must have time to reach the ambient temperature of the room before a calibration task is performed.
- The temperature of the water bath you use should be at least 2°C **below** the ambient temperature of the room where calibration is to be performed. So, if your ambient temperature is 20°C, make sure that the temperature of the water-bath you use is set at a maximum of 18°C.

Fig.12.6 Schematic diagram of the equipment necessary to produce a supply of clean, wet air.



12.5 General Settings – Stand-alone Use

Before a practical calibration task can be started, the monitor has to be informed about the kind of calibration task you wish it to perform. This is done using the push-buttons on the front panel of the Monitor.

The **Calibration Task** Set-Up Tree is illustrated in Fig.12.7. It should be used to help you follow the path through the different levels of the calibration set-up. The calibration tasks are set-up while operating in **Measure** mode.

Notice the following:

1. Before starting to set-up a calibration task you must make sure that you choose the correct FILTER BANK NO. to store the calibration factors which will be calculated during calibration (see section 12.3.3).

2. If you answer "YES" to **PERFORM ZERO-POINT CALIBRATION ?**, then the installed optical filters ("A") will be zero-point calibrated, and the **concentration offset factor** for the filter will be stored in the filter bank no. which is **active** for that filter during the practical calibration task.

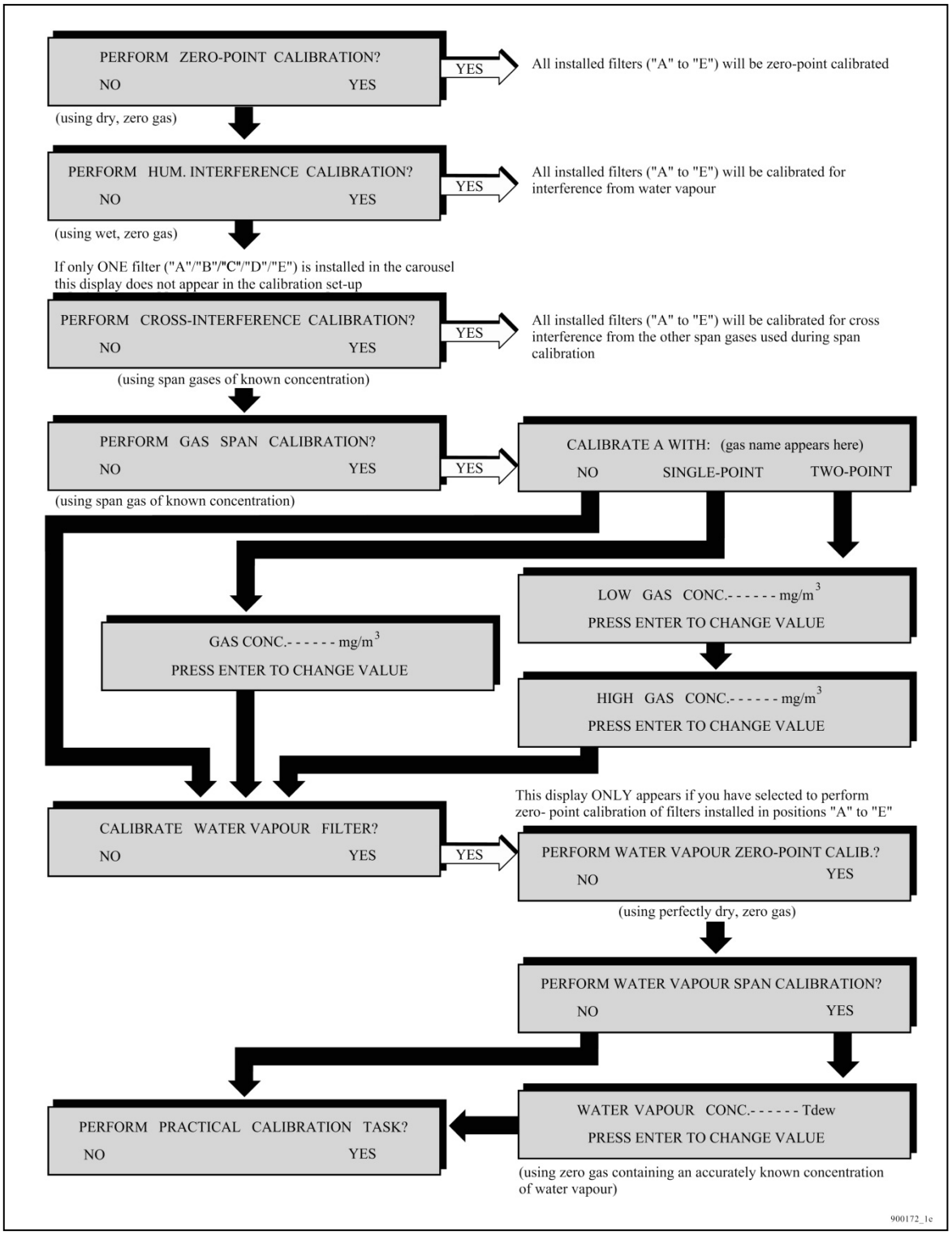
3. If you answer "YES" to **PERFORM HUM. INTERFERENCE CALIBRATION ?**, then the installed optical filters ("A") will be calibrated for humidity interference, and the **humidity gain factor** for the filter will be stored in the filter bank no. which is active for that filter during the practical calibration task.

4. If you answer "YES" to **PERFORM GAS SPAN CALIBRATION ?**, then you can choose (1) whether this calibration should be a single-point or a two-point span calibration. The **concentration conversion factor** calculated during span calibration for a particular gas using a particular filter), is stored in the filter bank no. which is **active** during the calibration procedure.

12.5.1 Retaining Existing Calibration Factors

In some case, you may wish to keep the calibration factors already present in your monitor. If this is the case, use the following instructions.

Fig.12.7 Schematic diagram showing the calibration task Set-Up Tree (general)


PERFORM ZERO-POINT CALIBRATION?
NO YES
YES
All installed filters ("A" to "E") will be zero-point calibrated
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
YES
All installed filters ("A" to "E") will be calibrated for interference from water vapour
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
YES
All installed filters ("A" to "E") will be calibrated for cross interference from the other span gases used during span calibration
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
YES
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
(using span gas of known concentration)
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
900172_1e

Before setting-up a calibration task, make sure that the filter bank you make **active** for the filter which have already been calibrated only contain **calibration factors** which need to be up-dated. In this way you can prevent your original **calibration factors** being overwritten by the new ones. To illustrate this, imagine that filter

"A",is installed in your Monitor and have been calibrated. Suppose **the calibration data block** of your Monitor contains the information shown in Fig.12.8 (notice no filter is installed in position "E") Suppose You now install an optical filter in position "E". This filter has to be fully calibrated . Before performing a zero-point and humidity interference task one of the following filter banks must be made **active**:

- Filter bank no. 3, 4 or 5 for filter "A";
- Filter bank no. 2, 3 or 5 for filter "B";
- Filter bank no. 2, 3 or 4 for filter "C";
- Filter bank no. 2, 3, 4 or 5 for filter "D".

Suppose you make filter bank no. 3 **active** for all the above filters and filter bank no. 1 **active** for filter "E". Then, after a zero-point calibration the **calibration data block** would contain the information shown in Fig.12.9. None of the original calibration data has been overwritten by the newly-calculated calibration factors.

Note: 3436i only have an optical filter in position A

Fig.12.8 Illustration of the calibration data stored in the filter banks of filters "A" to "D" before a zero-point calibration task

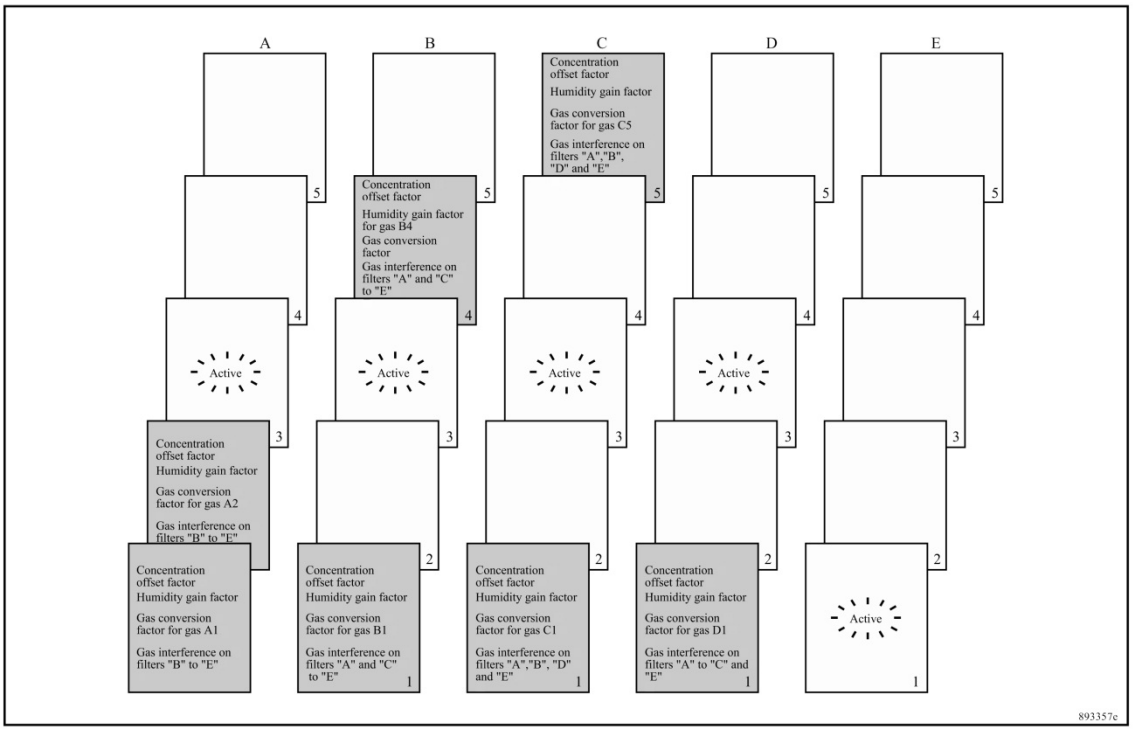
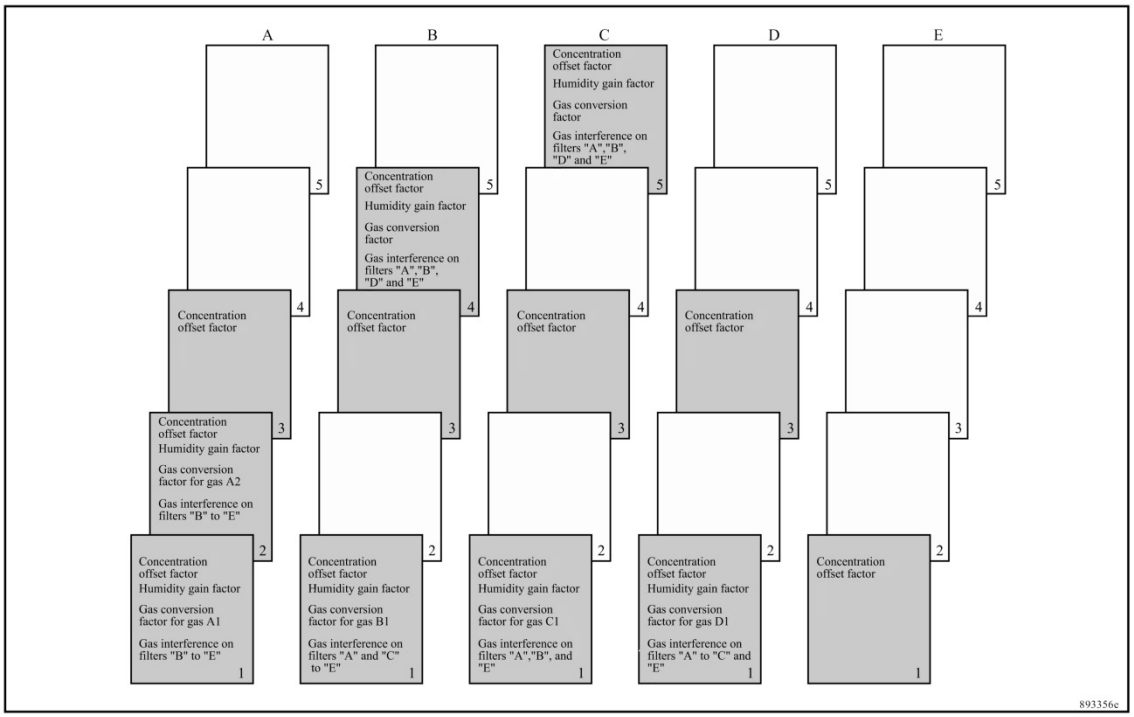

A
B
C
D
E
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas C5
Gas interference on filters "A","B", "D" and "E"
Concentration offset factor
Humidity gain factor for gas B4
Gas conversion factor
Gas interference on filters "A" and "C" to "E"
Active
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas A2
Gas interference on filters "B" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas A1
Gas interference on filters "B" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas B1
Gas interference on filters "A" and "C" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas C1
Gas interference on filters "A","B", "D" and "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas D1
Gas interference on filters "A" to "C" and "E"
893357e

Fig.12.9 Illustration of the calibration data stored in the filter banks of filters "A" to "E" after a zero-point calibration task


A
B
C
D
E
Concentration offset factor
Humidity gain factor
Gas conversion factor
Gas interference on filters "A","B", "D" and "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas A2
Gas interference on filters "B" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas A1
Gas interference on filters "B" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas B1
Gas interference on filters "A" and "C" to "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas C1
Gas interference on filters "A","B", and "E"
Concentration offset factor
Humidity gain factor
Gas conversion factor for gas D1
Gas interference on filters "A" to "C" and "E"
Concentration offset factor
893356e

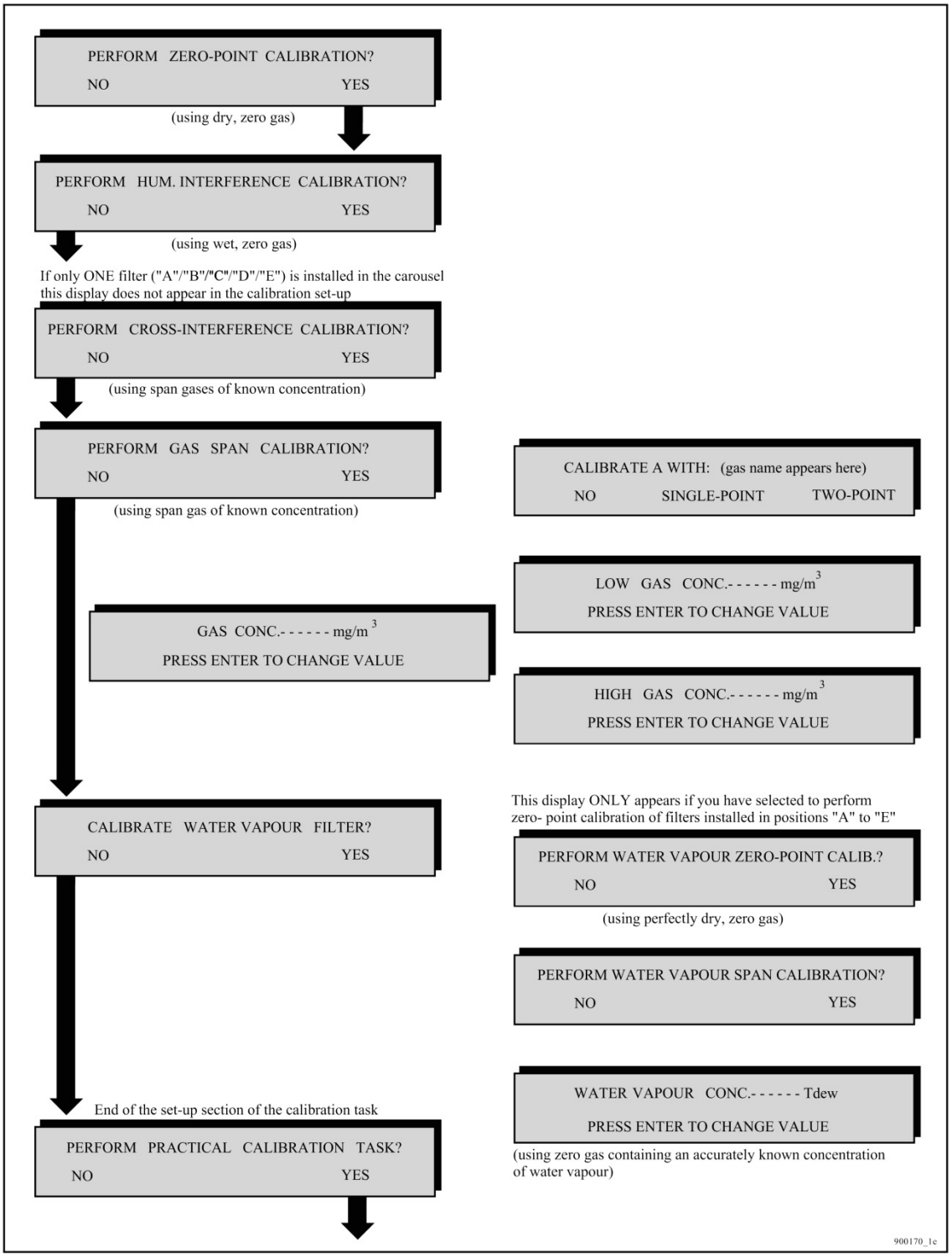
12.6 Zero-point Calibration

To calculate the **concentration offset factor** for a filter (during a zero-point calibration) it is necessary to have a **humidity gain factor** for the filter, and vice versa. If a **humidity gain factor** is not stored in each of the filter banks, which are **active** during a **zero-point** calibration, then it is necessary to perform a **combined** zero-point and humidity-interference calibration task. The set-up of this combined task is discussed in section 12.11.

If it is only a newly-installed optical filter which needs to be calibrated, then the same procedure used for an individual filter must be used, see section 12.5.1. In this way you can protect your original **concentration offset factors**.

12.6.1 Setting-up a Zero-point Calibration – Stand-alone Use

Fig.12.10 Schematic diagram showing how to set-up a zero-point calibration task (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
CALIBRATE WATER VAPOUR FILTER?
NO YES
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900170_1e

Use the Set-up Tree in Fig.12.10 to help you navigate through the different screen displays.

Note: before starting a calibration, S.I.T (see section 12.3.3) and Flushing Type (see section 7.2) need to be set so that they are the same as those values used when monitoring.

1. For each installed filter, enter the no. of the filter bank where you wish the Monitor to store the **concentration offset factors** which will be calculated during the zero-point calibration task.

2. Press **MEASURE** **S3** **S3** **S1**. The following text will be displayed:

PERFORM ZERO-POINT CALIBRATION ?
NO YES

3. Follow the set-up of a zero-point calibration task by following the black arrows in the schematic diagram shown in Fig.12.10.

The following text will appear on the display:

ZERO-POINT CALIB. CONNECT CLEAN, DRY AIR AND PRESS ENTER WHEN READY

12.6.2 Performing a Zero-point Calibration – Stand-alone Use

The general equipment necessary to perform a calibration task is described in section 12.4. Follow the procedure from step 1 to step 3 inclusive and then continue as follows:

1.
   a. Connect the free-end of the Teflon tubing mentioned in step 3 to the pressure valve on a cylinder of zero gas (e.g. pure nitrogen).

   b. Gently open the pressure-valve on the gas cylinder.

   c. Press ↵.

   d. Use the pressure-valve on the gas cylinder to regulate the flow of gas so that when the Monitor's pump is running there is a positive flow of gas **out** of the flow meter. This will ensure that the zero gas is not contaminated by atmospheric air.

   The following text appears on the screen:

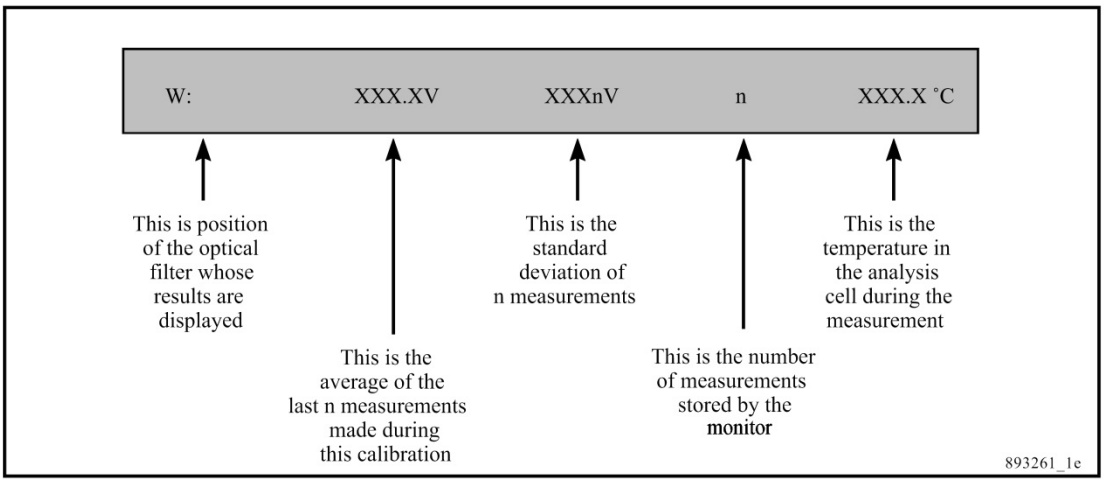
RESULTS NOT YET AVAILABLE
PLEASE WAIT

Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying the measurement results – for example the following:

W: μ : 11.3μV σ --- V 1 38.6°C
PRESS ENTER WHEN RESULTS ARE STABLE

As soon as measurement results are available they not only appear on the display (see Fig.12.11) but are automatically printed out on the printer, if the Monitor has been set up to print a data log, see section 10.5. Remember to turn off the data log when the calibration is complete.

Fig.12.11 Example of data displayed during a calibration (the text below the display describes the displayed data)


W: XXX.XV XXXnV n XXX.X °C
This is position of the optical filter whose results are displayed
This is the average of the last n measurements made during this calibration
This is the standard deviation of n measurements
This is the number of measurements stored by the monitor
This is the temperature in the analysis cell during the measurement
893261_1e

Each time a sample of gas is drawn into the analysis cell the signal is measured using **all** the installed optical filters and the water-vapour filter ("W") but, due to lack of space on the **display**, the Monitor only displays the signal measured using the water-vapour filter. You cannot scroll through the measurements. The data-log print-out, however, shows the signal measured using **all** installed filters as well as the water-vapour filter.

A maximum of 6 measurements are stored in the Monitor during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7th measurement so that only 6 measurements are still stored. When 8 measurements

have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7th and 8th measurement results …and so on.

2. Let the Monitor continue measuring the zero gas until the temperature in the cell is stable. Look at the print-out of the average and standard deviation measurements for (1) the water-vapour and (2) all the other filters. When all these values have stabilised calibration measurements, do not need to continue. Continue to the next step.

3. Press ↵.
   This causes the following text to appear on the screen:

A: μ : 5.28 μV σ : 94 nV 6 38.4°C
PRESS ENTER WHEN RESULTS ARE STABLE

   These results have been shown on the data-log print-out. If they have stabilised continue to the next Step.

4. Repeat step 3 until the signals measured with all the filters have been displayed, stabilised and been “accepted”.

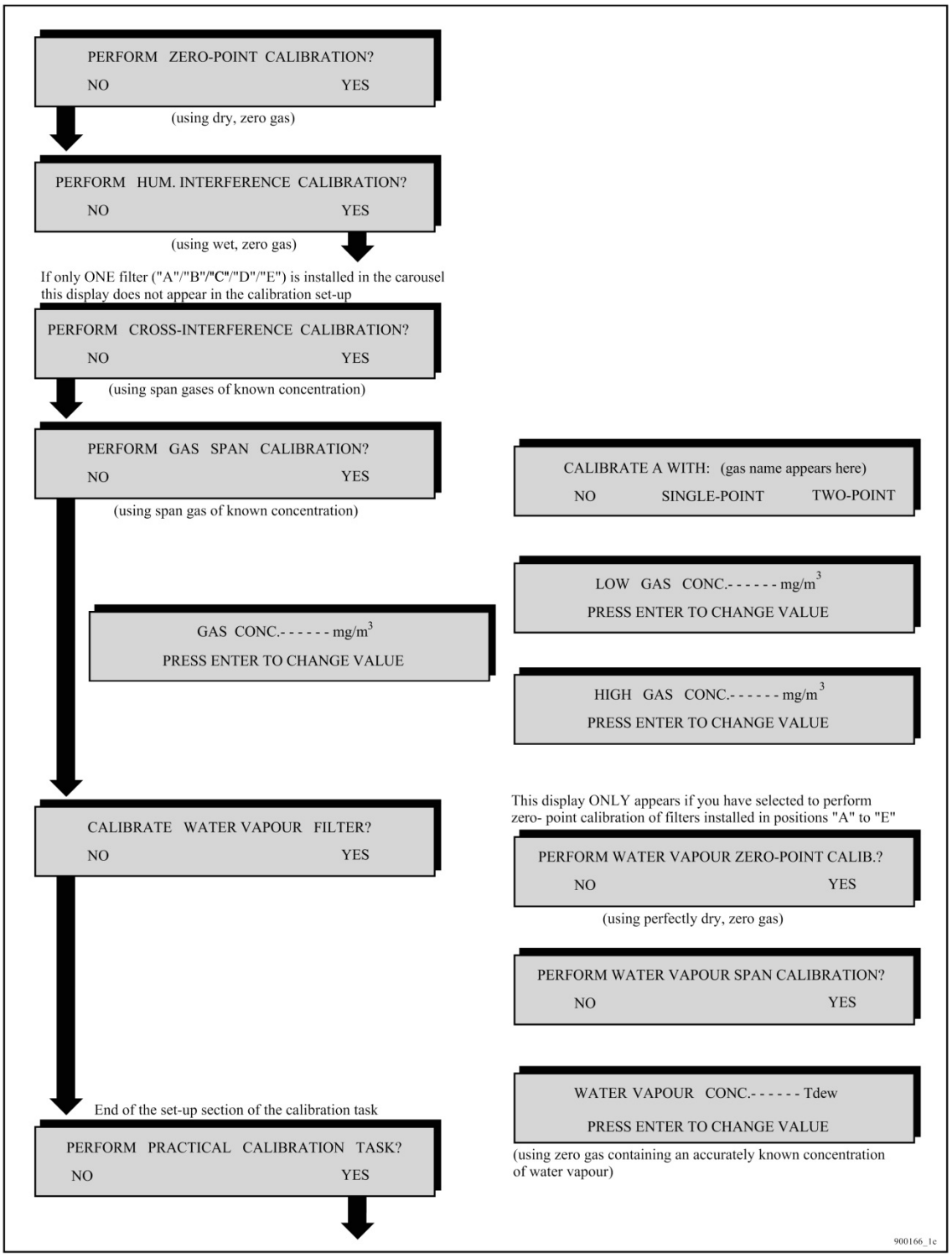
   The text **CALCULATION. PLEASE WAIT** appears on the screen.
   The Monitor only uses the last six measurement results when calculating any calibration factor. The **concentration offset factors** calculated during **zero-point calibration** of the filters, are related to the cell noise measured in the cell when each of the filters is being used.
   If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the Monitor can be obtained by pressing **INFO**.
   Chapter 13 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

12.7 Humidity-interference Calibrations – Stand-alone Use

If it is only a newly-installed optical filter which needs to be humidity-interference calibrated, then the same procedure used for a zero-point calibration of the filter must be used, see section 12.5.1. In this way you can protect your original **humidity gain factors**.

12.7.1 Setting-up a Humidity-interference Calibration Task

Fig.12.12 Schematic diagram showing how to set-up a humidity-interference calibration task (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
CALIBRATE WATER VAPOUR FILTER?
NO YES
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900166_1c

To calculate the **humidity gain factor** for a filter (during a humidity-interference calibration) it is necessary to have a

concentration offset factor for the filter, and vice versa. **Note: If a concentration offset factor is not stored in each of the filter banks which are active during a zero-point calibration, then it is necessary to perform a combined zero-point and humidity-interference calibration ta**sk. The set-up of this combined task is discussed in section 12.11.

If you only wish to set-up a humidity-interference calibration task the procedure is as follows:

1. For the installed filter, enter the no. of the filter bank where you wish the Monitor to store the **humidity gain factors** which will be calculated during the humidity-interference calibration task.

2. Press **MEASURE** **S3** **S3** **S1** then the following text will be displayed:

PERFORM ZERO-POINT CALIBRATION ?
NO YES

3. Follow the set-up of a humidity-interference calibration task by following the black arrows in the schematic diagram shown in Fig.12.12.
   The following text will appear on the display:

HUM. INTERFERENCE. CONNECT CLEAN, WET AIR AND PRESS ENTER WHEN READY

12.7.2 Performing a Humidity-interference Calibration

The general equipment necessary to perform a calibration task is described in section 12.4 and illustrated in Fig.12.5.
The gas supply required during a humidity-interference calibration is a supply of clean air containing a constant concentration of water vapour.

1. Follow the procedure explained in section 12.4 from steps 1 to 3 inclusive and the continue as follows:

2.
   a. Connect the outer end of the extra empty flask's outlet tube "B" to the Teflon tubing which is connected to attachment point 3 of the "Y"-piece (see Fig.12.6).

Caution: the inner end of the empty-flask's outlet tube "B" must NEVER be covered by water.

   b. Gently open the pressure-valve on the zero-gas cylinder.

c. Press ↵.

d. Use the pressure-valve on the zero-gas cylinder to regulate the flow of gas so that when the Monitor's pump is running there is a positive flow of gas out of the flow meter. This will ensure that the wet, zero gas is not contaminated by atmospheric air.

The following text appears on the screen:

RESULTS NOT YET AVAILABLE
PLEASE WAIT

The Monitor draws in the clean, wet air and measures the signal in the cell with the water-vapour filter as well as with **all** the other installed filters. Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying signal measured using the water-vapour filter – for example the following:

W: μ: 340 μV σ:--- V 1 39.3°C
PRESS ENTER WHEN RESULTS ARE STABLE

As soon as measurement results are available they do not only appear on the display but are automatically printed out on the printer, if the monitor is set up to print a data-log. Remember to turn off the data-log when the calibration is complete.
Each time a sample of gas is drawn into the analysis cell the signal is measured using **all** the installed optical filters and the water-vapour filter ("W") but, due to lack of space on the **display**, the Monitor first only displays the signal measured using the water-vapour filter. The data-log print-out, however, shows the signal measured using **all** installed filters as well as the water-vapour filter.

A maximum of 6 measurements are stored in the Monitor during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7th measurement so that only 6 measurements are still stored. When 8 measurements have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7th and 8th measurement results …and so on.

3. Let the Monitor continue measuring the clean, wet air until the temperature in the cell is stable. Look at the print-out of the

average and standard deviation measurements for (1) the water-vapour and (2) all the other filters. When all these values have stabilised, calibration measurements do not need to continue. Continue to the next Step.

4. Press ↵.
   This will cause the results of measurements made with all the other installed filters to be displayed, for example:

A : μ : 19.34 μV σ : 212 nV 6 39.3°C
PRESS ENTER WHEN RESULTS ARE STABLE

   These results have been printed out on the data-log printer. If they have stabilised continue to the next Step.

5. Repeat step 4 until the signals measured with all the filters have been displayed, stabilised and been “accepted”.

The text **CALCULATING PLEASE WAIT** appears on the screen.

The Monitor only uses the last six measurement results when calculating any calibration factor. The **humidity gain factors** calculated during **humidity-interference calibration** of the filters, are a measure of the sensitivity of each filter to water-vapour interference.

If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the Monitor can be obtained by pressing **INFO**.

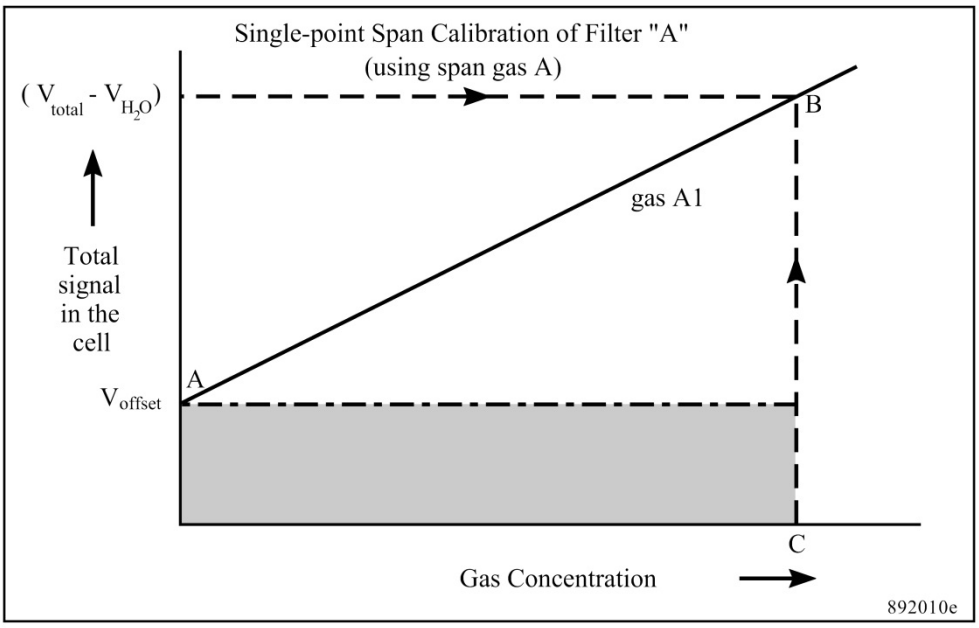
Chapter 13 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that you can ascertain what action to take if such messages are displayed after calibration.

12.8 Span Calibration

Before calculating the **conversion factor** for a filter (during span calibration) a **concentration offset factor** and a **humidity gain factor** must be in the filter bank which is selected for the filter during span calibration. Span calibration of a filter can therefore only be done after the filter has already been zero-point and humidity-interference calibrated.

During span calibration a supply of a particular gas (e.g. gas A1) of known concentration is attached to the air-inlet of the Monitor and the total signal in the cell is measured using the water-vapour filter and the filter which is being span calibrated (for example “A”). As filter “A” has already been calibrated for humidity interference, the total signal (V_{total}) measured with filter “A” can be compensated for any signal produced by water-vapour’s absorption of light from filter “A” (V_{H2O}) during the span calibration task. This means that your span gas does not have to be perfectly dry. As the filter has already been zero-point calibrated, the cell noise V_{offset} (when filter “A” is used) is known, and therefore the span calibration curve can be drawn (see Fig.12.13).

Fig.12.13 Curve showing a linear span-calibration curve



Choosing a filter bank

If a filter (e.g. “A”) has already been calibrated to measure a gas (e.g. A1) and you wish to calibrate with gas A1 again, then select the filter bank containing the **gas conversion factor** for gas A1. Online users can do this when downloading the calibration factors. Stand-alone users should do this before setting-up and performing the span calibration task. The **gas conversion factor** calculated during the span calibration will then just overwrite the **gas conversion factor** calculated during the previous span calibration of the filter with this gas.

If you wish to span calibrate a filter to measure more than one gas, then select a new filter bank each time you span calibrate with a

different gas. In this way **the conversion factor** for each gas is stored in separate filter banks (for stand-alone use see Fig.12.8).

The **gas conversion factor** stored in the selected filter bank during a span calibration task will be overwritten by the new **gas conversion factor** calculated during the span calibration of the filter.

Gas to be Used During Span Calibration

The gas you need to use during span calibration must be the gas you wish to measure with the filter.

Type of Span Calibration – Single-point or Two-point?

Fig.12.14a Graph showing a non- linear span-calibration curve which can be plotted using the signals measured during a two-point span calibration task

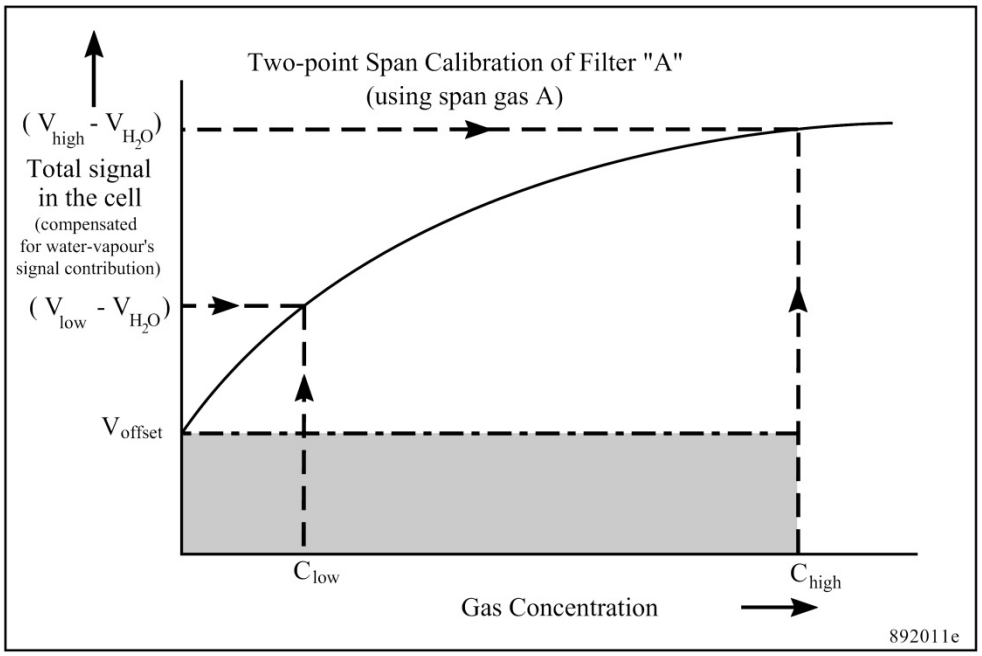
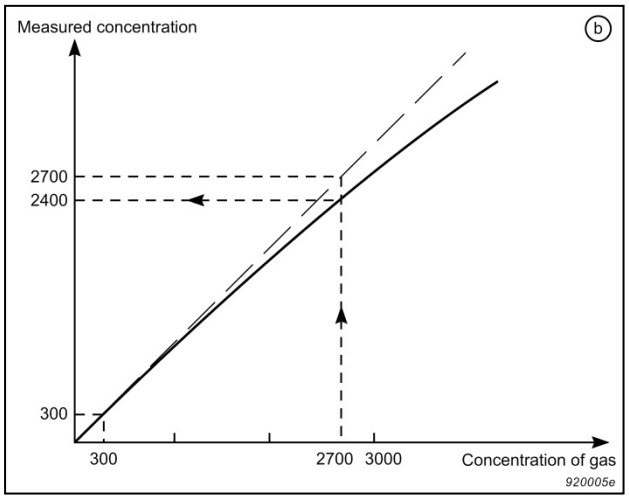


Fig.12.14b Graph showing a non- linear measurement curve



The question about whether to perform a single- or a two-point span calibration is difficult to answer, as it is dependent on how linear the relationship is between a gas's concentration and the signal it produces in the cell (see Fig.12.13, Fig.12.14a and Fig.12.14b). However, we can give you some guidelines on whether you have to perform a single- or a two-point span-calibration.

- Single-point calibration should be used when you wish to measure in the linear range. We define the linear range as the dynamic concentration range in which you can measure with an error of 5% of the real concentration (this is illustrated in Fig.12.14b). For the most common gases, the linear range is from its detection limit and up to 10 000 times its detection limit.

- Two-point calibration is recommended to be used when you wish to measure in the non-linear range and when you wish to measure over a dynamic range of 100 000.

Gas Concentrations – Single-point Calibration

If a single-point span-calibration is performed then the span gas should have a concentration which is at least 100 times its detection limit and preferable not more than the highest concentration you expect to measure.

For certain gases it can be inexpedient to use a concentration of at least 100 times its detection limit, e.g. if you wish to measure a poisonous gas with a high detection limit, it would be natural to use a lower concentration. However, this means that the noise and vibration will have a larger influence on the calibration. This must, therefore, be taken into account when considering using a lower concentration.

Gas Concentrations – Two-point Calibration

During a two-point span calibration, the total signal in the cell (V_{low}) is measured first with a low concentration (C_{low}) of span gas, and then the total signal in the cell (V_{high}) is measured with a high concentration (C_{high}) of span gas. This enables the Monitor to compensate for any un-linearity in the relationship between the signal measured in the cell and the concentration of the gas in the cell (this is illustrated, for a gas A1, in Fig.12.14a).

Here are some guidelines about the concentration of gas you should use during a two-point span calibration:

- The **Low Concentration** should be 10 to 30% of the highest concentration you expect to measure.
  If the desired measurement range is mainly within the linear range then the low concentration should be between 1000 and 10 000 times the detection limit.
  If the desired measurement range is mainly above the linear range then the low concentration should be more than 10 000 times the detection limit.

- The **High Concentration** should be 75% to 100% of the highest concentration you expect to measure, but no higher than this.

Simple Test to Determine the Linearity

Let us assume that you wish to measure a gas over a dynamic range from 100 ppm and 3000 ppm of a gas that has a detection limit of 0.3 ppm.

In this case, the range in which you want to measure is from 333 times to 10 000 times the detection limit. With our general guidelines, you're not able to decide whether you have to perform a single- or two-point calibration. Therefore, we advise you to perform the following test:

1. Perform a single-point calibration with a low concentration of the gas. Use 10% of the highest expected concentration level. In this case, use 300 ppm (1000 times the detection limit).

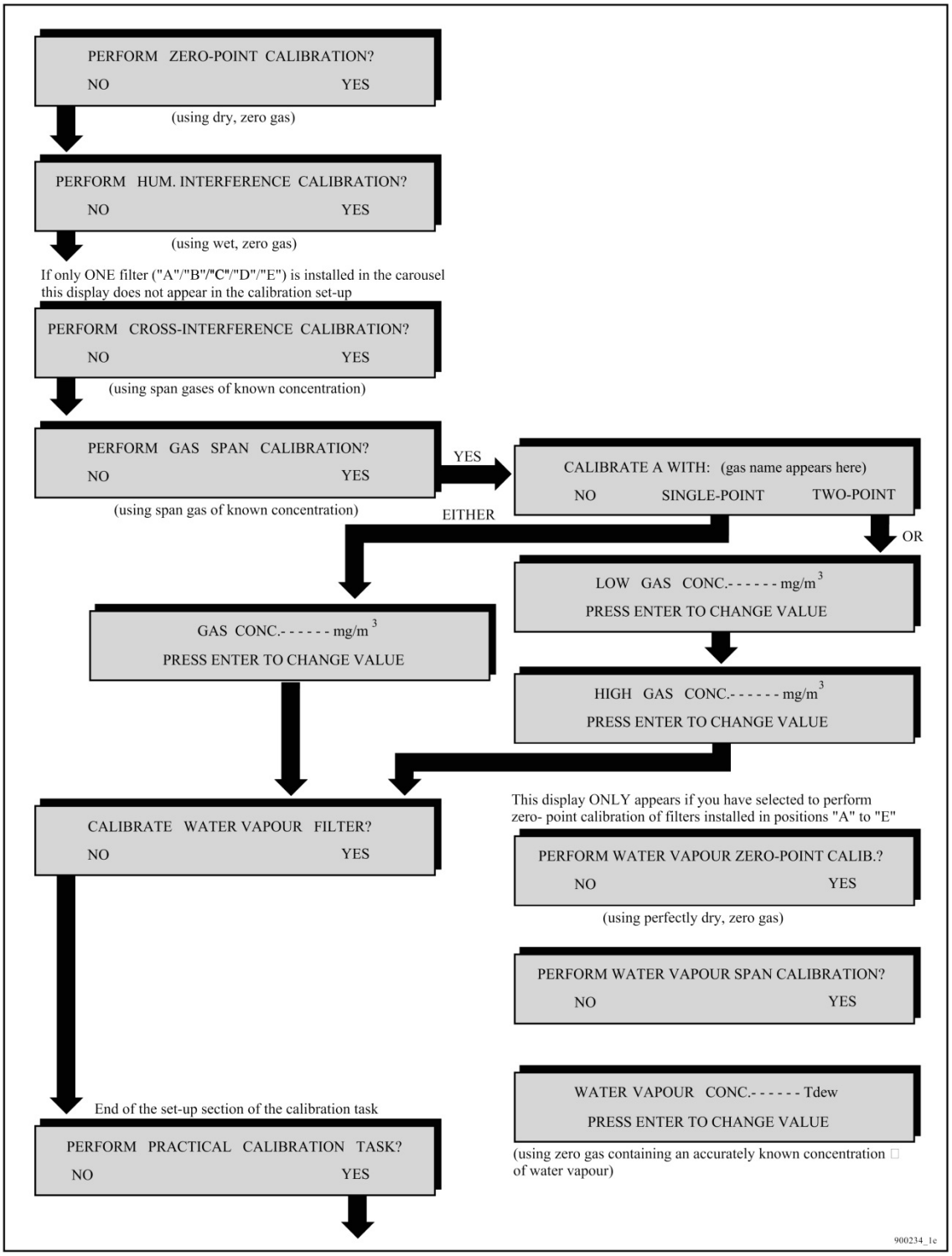
2. Perform a measurement with a high concentration of the gas. Use, for example, 90% of the highest expected concentration level. In this case, use 2700 ppm.

If the measured gas concentration differs by more than 5% from the real concentration, then a two-point calibration with 2 gas concentrations is recommended.

In the example in Fig.12.14b, we have measured 2400 ppm with 2700 ppm gas. This gives an error of 11% and an even greater error at the highest concentration level.

12.8.1 Setting-up a Span Calibration – Stand-alone Use

Fig.12.15 Schematic diagram showing how to set-up a span calibration task (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
EITHER
OR
GAS CONC.- - - - - - mg/m 3
PRESS ENTER TO CHANGE VALUE
LOW GAS CONC.- - - - - - mg/m 3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m 3
PRESS ENTER TO CHANGE VALUE
CALIBRATE WATER VAPOUR FILTER?
NO YES
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
(using perfectly dry, zero gas)
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900234_1e

1. For each filter being span calibrated, enter the No. of the filter bank where you wish the Monitor to store the **conversion factors** which will be calculated during the span calibration task.

2. Press **MEASURE** **S3** **S3** **S1** then the following text will be displayed:

PERFORM ZERO-POINT CALIBRATION?
NO YES

3. If you only wish to span calibrate filters, follow the set-up of a span calibration task by following the black arrows in the schematic diagram shown in Fig.12.15.

The following text will appear on the display:

CONNECT (the name of the gas appears here) XXXXXXmg/m^3 AND PRESS ENTER WHEN READY

Note: if the gas concentration on the "Analysis Certificate" is given in ppm then the following formula can be used to convert from parts per million units (ppm) to mg/m^3:

For a gas at 20°C and at 1 atmosphere pressure:

$$\text{Concentration (in mg/m}^3\text{)} = \left(\frac{\text{Concentration (in ppm) x Molecular Weight (in g)}}{24{,}04} \right)$$

12.8.2 Performing a Span Calibration – Stand-alone Use

The general equipment necessary to perform a calibration task is described in section 12.4. Follow the procedure from step 1 to step 3 inclusive and then continue as follows:

1.
   a. Connect the free-end of the Teflon tubing mentioned in step 3 to the pressure valve on a cylinder of calibration gas.

   b. Press ↵.

   c. Gently open the pressure-valve on the gas cylinder and regulate the flow of gas so that when the Monitor's pump is

running there is a positive flow of gas out of the flow meter. This will ensure that the calibration gas is not diluted by atmospheric air.

The following text appears on the screen:

RESULTS NOT YET AVAILABLE
PLEASE WAIT

Once the first measurement result is available the screen text illustrated above is replaced by a screen displaying the measurement results – for example the following:

W: μ: 5.34 μV σ: 212 nV 3 40.4 °C
PRESS ENTER WHEN RESULTS ARE STABLE

As soon as measurement results are available, they not only appear on the display (see Fig.12.11) but are automatically printed out on the printer, if the Monitor has been set up to print a data log, see section 10.5. Remember to turn off the data log when the calibration is complete.
Each time a sample of gas is drawn into the analysis cell the signal is measured using both optical filter "A" and the water-vapour filter ("W") but, due to lack of space on the **display**, the Monitor only displays the signal measured using the water-vapour filter. The data-log print-out, however, shows the signal measured using both the water-vapour filter and filter "A".
A maximum of 6 measurements are stored in the Monitor during any calibration. The number (n) indicates how many measurements are stored. When 7 measurements have been performed the number (n) will show the number 6 because the very first measurement is overwritten by the 7th measurement so that only 6 measurements are still stored. When 8 measurements have been completed the number (n) will also show 6 because the results of the first and second measurements have been overwritten by the 7th and 8th measurement results …and so on.

2. Let the Monitor continue measuring the span gas A until the temperature is stable. Look at the print-put of the average and standard deviation measurements for (1) the water-vapour and (2) the filter "A". When these values have stabilised for both filters, span calibration measurements do not need to continue.

3. Press ↵.
   This causes the following text to appear on the screen:

A : μ : 123.8 μV σ : 617 nV 6 40.4 °C
PRESS ENTER WHEN RESULTS ARE STABLE

These results have been shown on the data-log print-out. If they have stabilised continue to the next Step.

4. Press ↵.

The text **CALCULATING CALIBRATION FACTORS – PLEASE WAIT** appears on the screen.

The Monitor only uses the last six measurement results when calculating any calibration factor. The **conversion factor** (in mg/m3 per volt), which is calculated during a **span calibration**, is the factor which allows the Monitor to relate the signal produced by the gas to the concentration of gas in the cell.
If any calibration data is doubtful or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is shown on the screen further information about the condition of the Monitor can be obtained by pressing the **INFO** button.

Chapter 13 lists all the error messages connected with doubtful calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

12.9 Calibration of the Water-vapour Filter – Stand-alone Use

The water-vapour filter has two different functions. Its most important function is to enable any measured signal to be compensated for water-vapour interference. Its other function is to measure the absolute concentration of water-vapour in air samples. If you only wish to use the water-vapour filter to compensate for water-vapour interference, then it only has to be **zero-point calibrated**. If you wish to use it to measure the absolute concentration of water vapour in air samples then it has to **be zero-point calibrated** and **span calibrated**.

It is **vitally** important to accurately zero-point calibrate the water-vapour filter as this influences the Monitor's ability to compensate for interference from water vapour. This demands that the zero-gas you use during the zero-point calibration of the filter must be perfectly dry.

12.9.1 Setting-up a Zero-point Calibration of the Water-vapour Filter

If you wish to zero-point calibrate the water-vapour filter you **must** zero-point calibrate all installed optical filters. The **concentration offset factors** calculated during zero-point calibration of the filter "A" will be stored in the filter banks (the **active** during calibration). Check, therefore, that you make the relevant filter bank active for the filter before calibrating it. This is discussed in more detail in section 12.3.3.

The procedure for setting-up a zero-point calibration of the water-vapour filter is as follows:

1. Press **Measure** **S3** **S3** **S1** then the following text will be displayed:

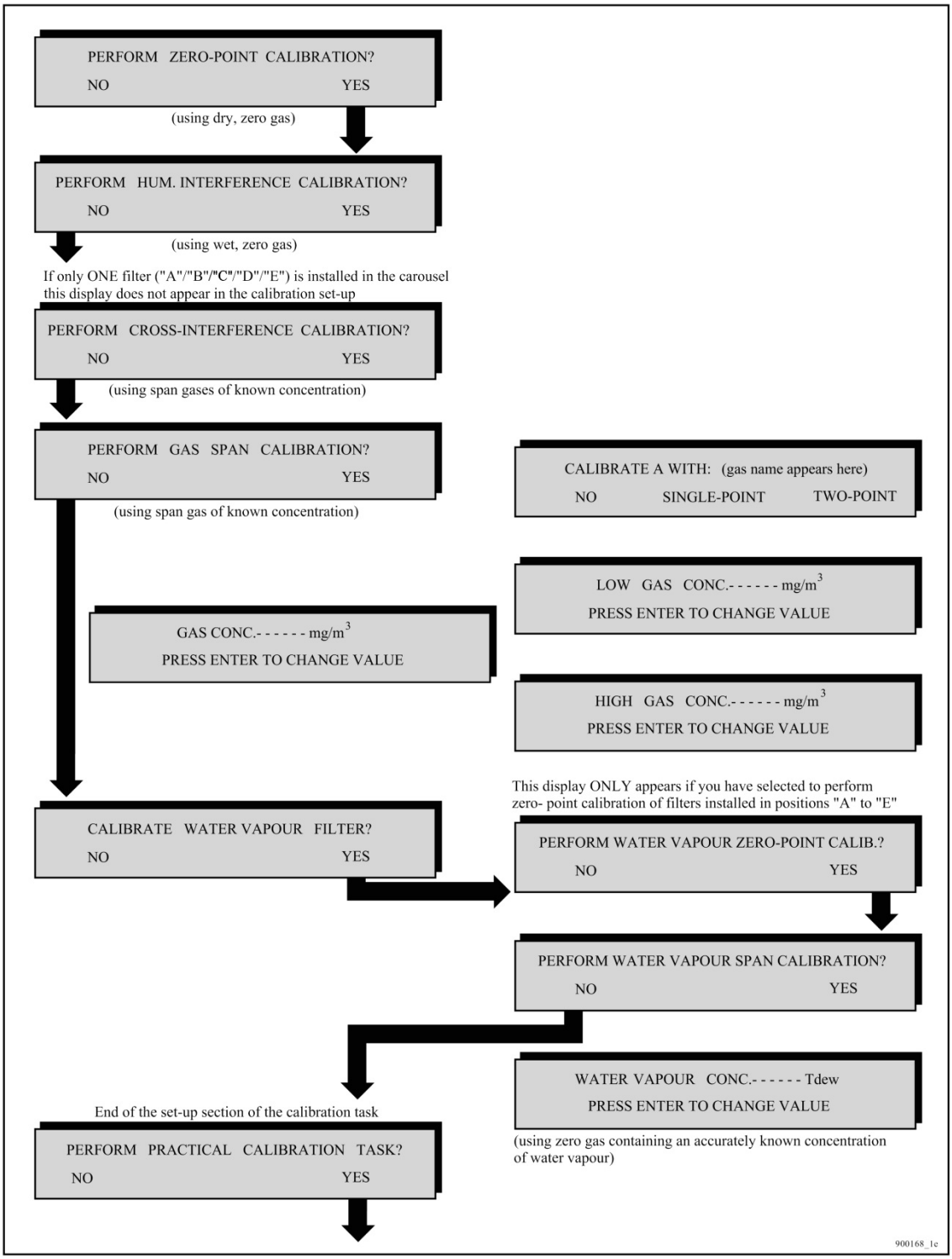
PERFORM ZERO-POINT CALIBRATION ?
NO YES

2. Follow the set-up of a zero-point calibration of the water-vapour filter by following the black arrows in the schematic diagram shown in Fig.12.16.

The following text will appear:

ZERO-POINT CALIB. CONNECT CLEAN, WET AIR AND PRESS ENTER WHEN READY

Fig.12.16 Schematic diagram showing how to set-up a zero-point calibration task for the water-vapour filter (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900168_1e

12.9.2 Performing a Zero-point Calibration of the Water-vapour Filter

As explained in the previous section, a zero-point calibration of the water-vapour filter has to be done together with the zero-point calibration of the other installed optical filters. The latter task has been fully described in section 12.6. It is worth-while to emphasise again that it is **vitally important** to use perfectly dry zero-gas (that is, zero-gas which contains 0% water-vapour) during this calibration.

Note that during the zero-point calibration of filter "A" (task 1, shown below), and during the combined zero-point calibration of filter "A" **and** the water-vapour filter (task 2, shown below), a zero-gas supply is attached to the air-inlet of the Monitor. The Monitor measures the signal in the cell using the water-vapour filter and the other installed optical filter. Signals measured with filter "A" enable the **concentration offset factors** for filter "A" to be stored in the filter bank which is **active** during calibration. However, the signal measured with the water-vapour filter is used differently:

In Task 1:
The signal measured with the water-vapour filter is used to compensate all measured signals for any interference caused by the presence of any residual water-vapour in the zero-gas supply.

In Task 2:
The signal measured with the water-vapour filter is used to update the **concentration offset factor** for the water-vapour filter. This means that the signals measured with filter "A" be compensated for the presence of any water vapour present. This is why it is **vitally important** to use **perfectly dry** zero-gas during this task.

Please refer to section 12.6.2 for details about how to perform a zero-point calibration task.

12.9.3 Setting-up a Span Calibration of the Water-vapour Filter

Remember that span calibration of the water-vapour filter is only necessary if you wish to measure the absolute concentration of water vapour in air samples. If the water-vapour filter is not **span** calibrated you will not be able to measure the concentration of water vapour in gas samples during a monitoring task.

Before the water-vapour filter can be span calibrated, it has to be zero-point calibrated, that is, a **concentration offset factor** for the

water-vapour filter must be stored in the Monitor's calibration data block.

During span calibration of the water-vapour filter it is necessary to attach a supply of zero-gas containing a known concentration of water vapour to the Monitor. As explained in the Humidity-interference Calibration (Section 12.7.2) it is important to use water-vapour whose concentration is below the saturated vapour pressure of water-vapour at the temperature of the room where calibration is to be performed, otherwise water-vapour will condense out in the analysis cell and damage it.

Before setting-up the span calibration of the water-vapour filter go into **Set-Up mode** and select "Tdew" as a humidity unit. Then when you have to enter the concentration of the water-vapour you will use during calibration. Always use water concentrations at least 2°C below the ambient room temperature. For example, if the ambient room temperature is 20°C then you can **ENTER WATER-VAPOUR CONC** as 18°Tdew.

The procedure for setting-up a span calibration of the water-vapour filter is as follows:

1. Press **Measure** **S3** **S3** **S1** then the following text will be displayed:

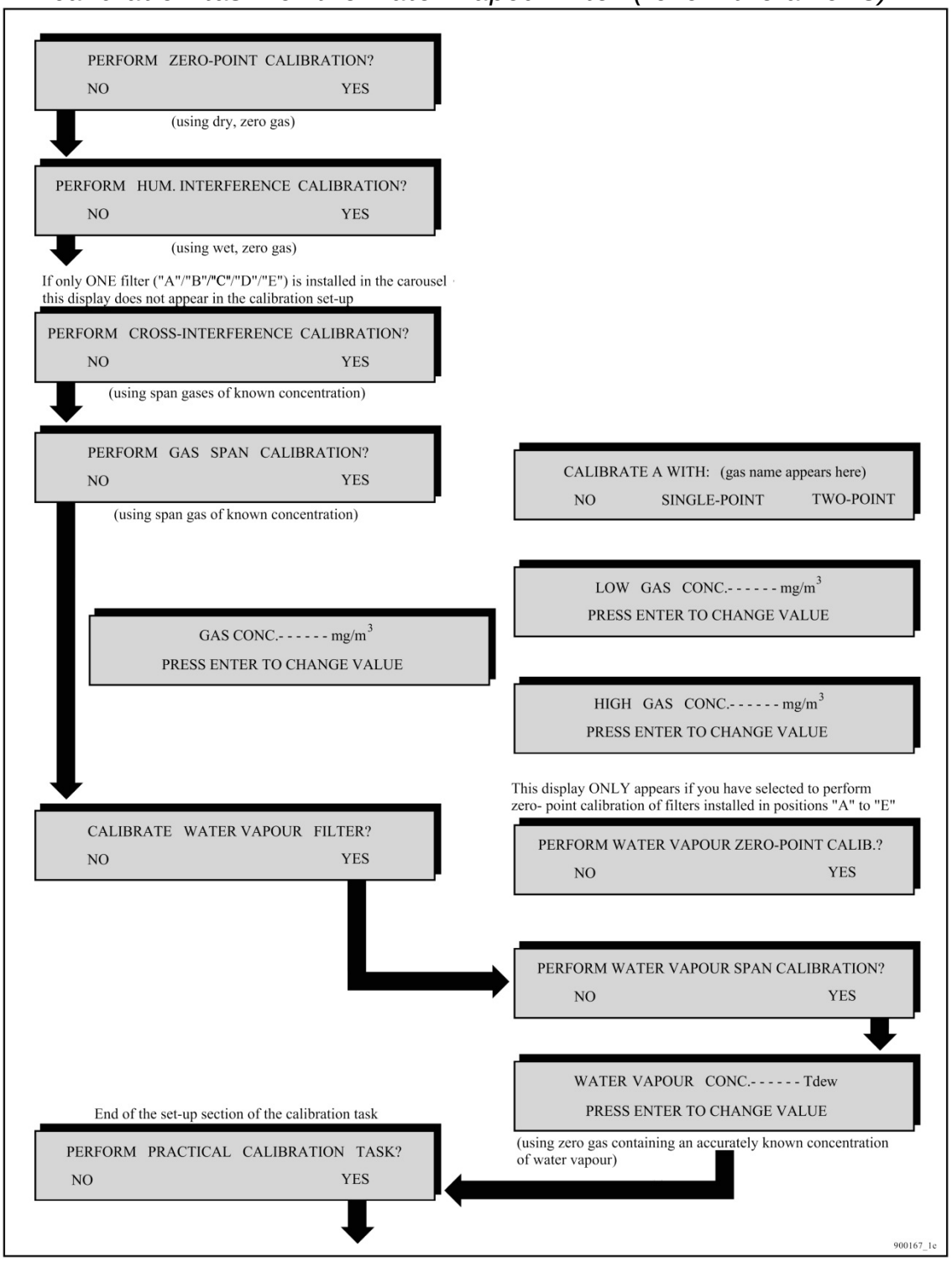
PERFORM ZERO-POINT CALIBRATION ?
NO YES

2. Follow the set-up of a span calibration of the water-vapour filter by following the black arrows in the schematic diagram shown in Fig.12.17.

The following text will appear:

CONNECT WATER-VAPOUR 18.0 Tdew AND PRESS ENTER WHEN READY

Fig.12.17 Schematic diagram showing how to set-up a span calibration task for the water-vapour filter (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900167_1c

12.9.4 Performing a Span Calibration of the Water-vapour Filter

Section 12.4.1 describes a good method of producing water-vapour of known concentration. The directions for performing a span calibration of water-vapour filter are similar to those for performing a humidity-interference calibration of the other installed filters is as described in section 12.7.2. In both calibration tasks the signal in the cell is measured when a supply of zero gas containing a constant concentration of water vapour is attached to the Monitor. There are, however, two differences:

1. During a humidity-interference calibration the signal is measured using the installed filter (including the water-vapour filter), whereas during the span calibration of the water-vapour filter the signal is only measured with the water-vapour filter.

2. During a humidity-interference calibration, it is **not** necessary to know the concentration of water-vapour supplied to the cell as it is only necessary to measure the size of each signal (with filter "A") relative to the size of the signal measured with the water-vapour filter. However, during a span calibration of the water-vapour filter it **is** necessary to know the **exact** concentration of water-vapour supplied to the cell, because during this calibration the **conversion factor** is calculated. This factor relates the measured signal to the concentration of water-vapour in the cell.

Follow the procedure described in section 12.7.2.

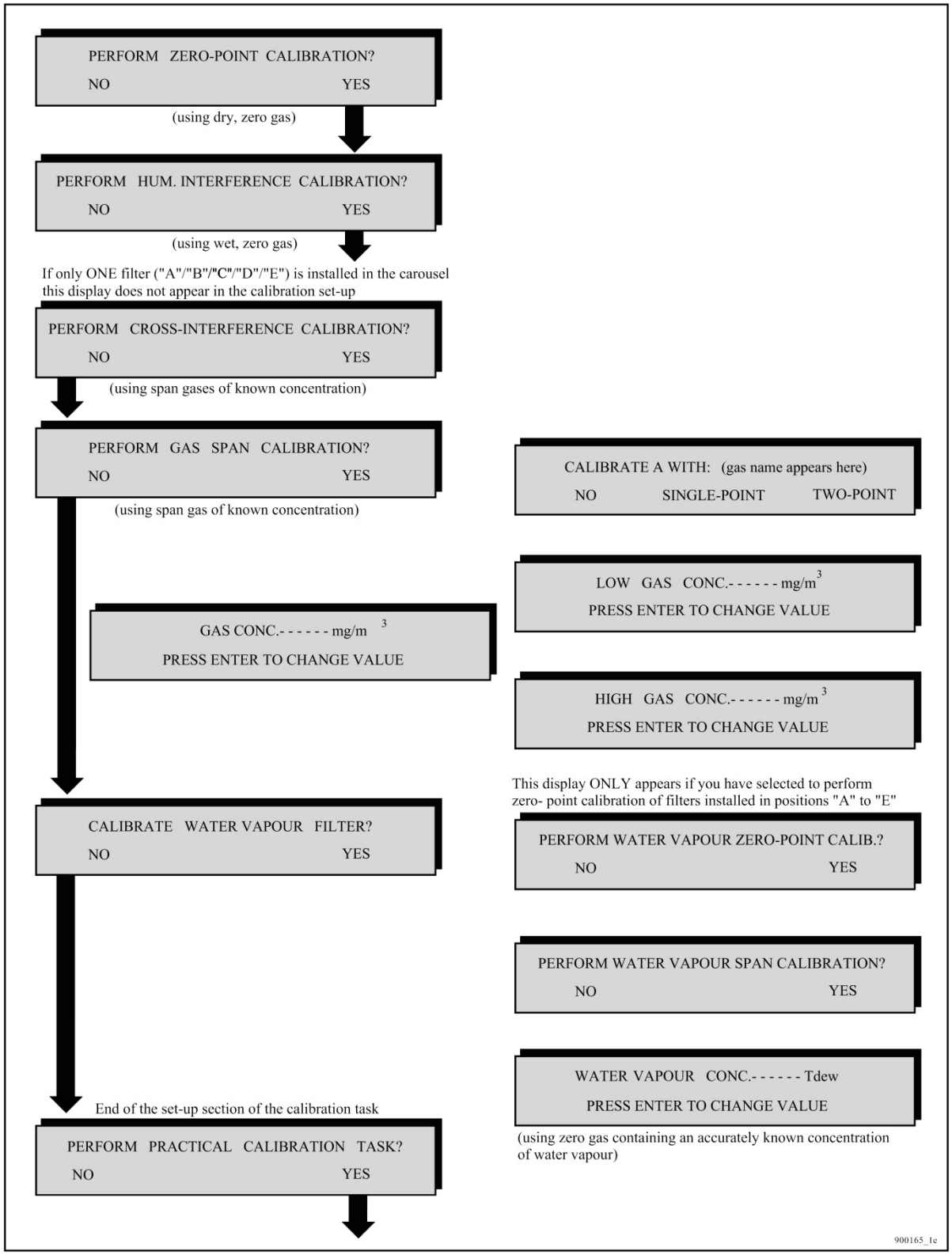
12.10 Setting-up a Combined Zero-point and Humidity-interference Calibration – Stand-alone Use

We have explained in previous sections of this chapter (section 12.6 and section 12.7.1) that a zero-point calibration can only be performed alone if a **humidity gain factor** is already stored in the filter bank which are **active** during the zero-point calibration task. Likewise, a humidity-interference calibration can only be performed alone if a **concentration offset factor** is already stored in the filter bank which is **active** during the humidity-interference calibration task.

If the necessary calibration factors are not stored in the Monitor's memory, a zero-point calibration task has to be performed together with a humidity-interference calibration task.

The procedure for setting-up a **combined** zero-point **and** humidity-interference calibration task is as follows:

Fig.12.18 Schematic diagram showing how to set-up a combined zero-point and humidity-interference calibration task (follow the arrows)


PERFORM ZERO-POINT CALIBRATION?
NO YES
(using dry, zero gas)
PERFORM HUM. INTERFERENCE CALIBRATION?
NO YES
(using wet, zero gas)
If only ONE filter ("A"/"B"/"C"/"D"/"E") is installed in the carousel this display does not appear in the calibration set-up
PERFORM CROSS-INTERFERENCE CALIBRATION?
NO YES
(using span gases of known concentration)
PERFORM GAS SPAN CALIBRATION?
NO YES
(using span gas of known concentration)
CALIBRATE A WITH: (gas name appears here)
NO SINGLE-POINT TWO-POINT
LOW GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
HIGH GAS CONC.- - - - - - mg/m3
PRESS ENTER TO CHANGE VALUE
This display ONLY appears if you have selected to perform zero- point calibration of filters installed in positions "A" to "E"
CALIBRATE WATER VAPOUR FILTER?
NO YES
PERFORM WATER VAPOUR ZERO-POINT CALIB.?
NO YES
PERFORM WATER VAPOUR SPAN CALIBRATION?
NO YES
WATER VAPOUR CONC.- - - - - - Tdew
PRESS ENTER TO CHANGE VALUE
(using zero gas containing an accurately known concentration of water vapour)
End of the set-up section of the calibration task
PERFORM PRACTICAL CALIBRATION TASK?
NO YES
900165_1e

1. Press **Measure** **S3** **S3** **S1** then the following text will be displayed:

PERFORM ZERO-POINT CALIBRATION ?
NO YES

2. Follow the set-up of a combined zero-point and humidity-interference calibration by following the black arrows in the schematic diagram shown in Fig.12.18.

The following text will appear:

ZERO-POINT CALIB. CONNECT CLEAN, DRY AIR AND PRESS ENTER WHEN READY

3. Refer to section 12.6.2 for the practical details of a zero-point calibration task.

When the zero-point calibration task is complete, the following text appears on the screen:

HUM. INTERFERENCE. CONNECT CLEAN, DRY AIR AND PRESS ENTER WHEN READY

4. Refer to Section 12.7.2 for the practical details of a humidity-interference calibration task.

12.11 Setting-up any Combined Calibration – Stand-alone Use

Although we have separated the various calibration tasks and described how to set them up and perform them alone, it is, of course possible to set-up any combination of calibration tasks, for example, that combining the zero-point and humidity-interference calibration tasks described in Section 12.11.

After setting-up any combined calibration task, the Monitor responds by telling you about which gas supply is required for each calibration task.

When the combined calibration task is complete, the text **CALCULATING. PLEASE WAIT** appears on the screen.

If any calibration data is uncertain or unacceptable an error message (marked by an asterisk) will appear on the screen after the calibration factors have been calculated. Whenever an asterisk is

shown on the screen further information about the condition of the Monitor can be obtained by pressing **INFO**.

Chapter 13 lists all the error messages connected with uncertain calibration results and gives an explanation of their significance so that the user can ascertain what action to take if such messages are displayed after calibration.

Chapter 13

Messages Related to Calibration

April 2015

All the possible error messages connected with calibration results are discussed in this chapter. Messages fall into three calibration categories: (1) successful; (2) uncertain and (3) invalid. An explanation is given of each message and its significance so that the user can ascertain what action to take if such messages are displayed after calibration.

13.1 "Successful" Calibration Messages

The messages listed below indicate (1) that the calibration task you have just performed has been successful, and (2) that the calibration factor calculated during the calibration task has been stored in the filter bank which was **selected / active** during the calibration task.

ZERO-POINT CALIBRATION SUCCESSFUL
HUM. INTERFERENCE CALIBRATION SUCCESSFUL
ZERO-POINT/HUM. INTERF. CALIB. SUCCESSFUL
GAS X* SINGLE-POINT CALIBRATION SUCCESSFUL
GAS X* TWO-POINT CALIBRATION SUCCESSFUL

Where Gas X is the gas used during the span calibration of the filter installed in position "X" of the filter carousel (Where: X = "A" or "W").

13.2 "Successful *" Calibration Messages

The messages listed below indicate (1) that the calibration task you have just performed is perhaps not as good as can be expected; (2) that the calibration factor which has just been calculated **has** been stored in the filter bank which was active during the calibration task; and (3) that you will have to judge the validity of the calibration. If you judge it to be invalid then the task will have to be repeated so that the calibration factor stored in the filter bank can be overwritten by a new and valid factor.

You can find out why there is uncertainty about the validity of the calibration factor by pressing **INFO**.

The messages displayed when **INFO** is used are discussed in section 13.4.

ZERO-POINT CALIBRATION SUCCESSFUL*
HUM. INTERFERENCE CALIBRATION SUCCESSFUL*
ZERO-POINT/HUM. INTERF. CALIB. SUCCESSFUL*
GAS X* SINGLE-POINT CALIB. SUCCESSFUL*
GAS X* TWO-POINT CALIBRATION SUCCESSFUL*

13.3 "Invalid" Calibration Messages

The messages listed below indicate: (1) that the calibration factor calculated during the calibration task you have just performed is not valid and therefore has not been stored in any filter bank; and (2) that the calibration task must therefore be repeated.

ZERO-POINT CALIBRATION INVALID*
HUM. INTERFERENCE CALIBRATION INVALID*
ZERO-POINT/HUM. INTERF. CALIB. INVALID*
GAS X* SINGLE-POINT CALIB. INVALID*
GAS X* TWO-POINT CALIBRATION INVALID*

13.4 Error Messages Displayed when the INFO button is used

All "successful*" or "invalid" calibration messages are marked with an asterisk (*) which tells you that more detailed information about the calibration can be obtained by pressing **INFO**. The messages displayed when **INFO** is pressed are listed and explained below.

13.4.1 "Invalid" Error Messages

MISSING MEASUREMENT DATA

This message indicates that the Monitor does not have the necessary data to calculate absolutely valid calibration factors. This situation could, for example, be caused by too much noise in the analysis chamber. The calibration task will have to be repeated.

WATER VAPOUR MEASUREMENT < OFFSET

This message is associated with either (1) a span calibration of the water-vapour filter, or (2) a humidity-interference calibration.

This message indicates that the signal measured with a particular filter, when water-vapour of known concentration is in the analysis cell, is less than the signal measured in the cell when zero-gas is in the cell. This could indicate either:

- That the gas used during the zero-point calibration of the filter was not dry;
  or
- That the water vapour used during either the span calibration of the water-vapour filter; or the humidity-interference calibration, was not wet enough.

WET MEAS. < DRY MEAS. FOR WATER FILTER and

HUMIDITY INTERFERENCE FACTOR < 0

Both these messages are associated with a combined zero-point and humidity-interference calibration task.

WET MEAS. < DRY MEAS. FOR WATER FILTER

HUMIDITY INTERFERENCE FACTOR < 0

During the zero-point calibration task the signal is measured when dry, zero gas is in the cell – this is a measure of the noise in the cell when a particular optical filter is used. This measurement allows the **concentration offset factor** for the particular filter to be calculated. During the humidity-interference calibration task the signal in the cell when a particular optical filter is used is measured when wet, zero gas is in the cell – this signal is compared with the signal measured with the water-vapour filter to give the **humidity gain factor**. The above message is given if the **humidity gain factor** is found to be less than zero. This could indicate that the zero-gas you used during the zero-point calibration was not dry, or alternatively that the concentration of water-vapour you used during the humidity-interference calibration was too low.

GAS X: CALIBRATION FACTOR LESS THAN 0

This message is associated with a single-point span calibration task.

The **gas conversion factor** calculated during the single-point span calibration task is found to be less than zero. This could indicate that the concentration of gas used during the calibration was too low.

GAS X: LOW MEAS. > HIGH MEAS.

GAS X: MEAS. INDICATES LINEAR COHERENCE

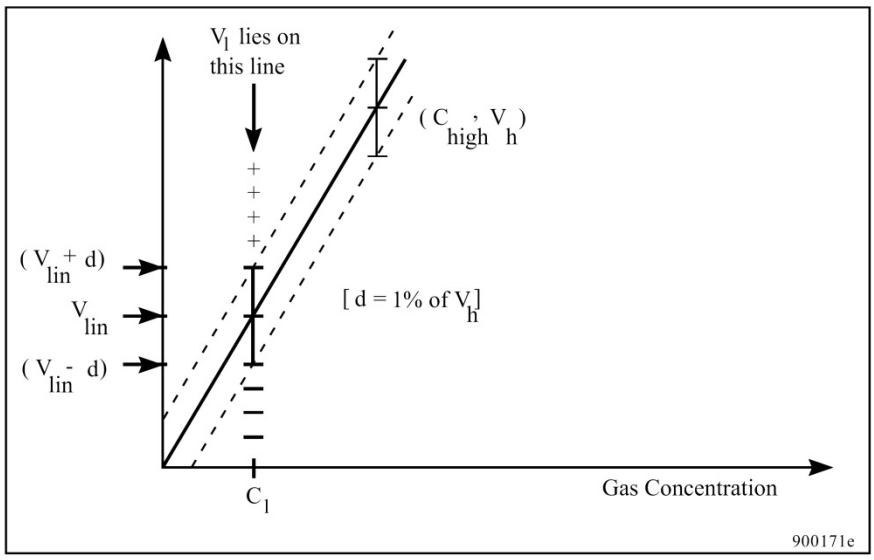
GAS X: MEAS. DOES NOT FIT NON-LINEAR CURVE

GAS X: CALIBRATION IMPOSSIBLE: MAX ITER.

All these messages are associated with a two-point span calibration task.

During a two-point span calibration the signal (V_{high}) is measured when the gas concentration C_{high} is in the cell, and the signal (V_{low}) is measured when the gas concentration C_{low} is in the cell (see section 12.8).

Fig.13.1 Curve illustrating the two points measured during a two-point span calibration task



GAS X: LOW MEAS. > HIGH MEAS.

This message indicates that the signal measured in the cell when the gas concentration was low is found to be greater than the signal when the gas concentration was high.

The above message could indicate that the span gas concentrations were incorrectly “entered” when the task was set-up (that is, the “entered” low gas concentration was actually greater than the “entered” high gas concentration). Alternatively, it could indicate that the concentration of the gas supplied to the Monitor during the measurement of V_{low} was actually the high concentration (C_{high}) and vice versa.

The signals V_{high} and V_{low} have to be corrected for water-vapour interference and cell noise, that is:

$$V_{high} - V_{offset} - V_{H2O} = V_h;$$

and:

$$V_{low} - V_{offset} - V_{H2O} = V_l$$

These two points (V_h, C_h) and V_l, C_l) can then be plotted on a graph (see Fig.13.1).

When the two signals have been measured, the Monitor then finds the value δ = 1% of V_h and finds out the relationship between the measured values:

If there is a perfectly linear relationship between the points C_{low}, V_{low} and C_{high}, V_{high} then:

$$V_{lin} = (C_h / C_l) * V_l$$

GAS X: MEAS. INDICATES LINEAR COHERENCE

This message will be given in the status display if V_l lies between the values $V_{lin} - \delta$ and $V_{lin} + \delta$. This indicates that the two gas concentrations you have chosen lie in the linear region of the calibration curve. If the high concentration of gas you used (C_{high}) is equal to or greater than the highest concentration you expect to measure, then it is not necessary to use a two-point span calibration, a single-point span calibration using C_{high} as the concentration of span gas used will be sufficient to give you a good calibration result. However, if the high concentration of gas you used is less than the highest gas concentration you expect to measure, the two-point span calibration task should be repeated using a high concentration which is equal to or greater than the highest concentration you expect to measure. There will therefore be a better chance to find a point in the non-linear region of the span calibration curve so that any non-linearity can be plotted.

GAS X: MEAS. DOES NOT FIT NON-LINEAR CURVE

This message will be given in the status display if V_l is less than $V_{lin} - \delta$. This message indicates that a two-point span calibration cannot be performed.

If V_l is found to be greater than $V_{lin} + \delta$ then the Monitor will try to fit the two measured points onto a curve, whose shape has been pre-determined by *LumaSense*, by an iterative process. The iterative process involves scaling on the concentration and signal axes until the two points fit the curve within certain tolerances.

GAS X: CALIBRATION IMPOSSIBLE: MAX ITER.

If after 255 iterative processes, the two points cannot be fitted onto the curve within tolerance limits, this message is displayed.

This could indicate that the wrong concentration has been “entered” in the set-up of the span calibration task (which does not relate to the measured signal). Alternatively, it could indicate that there is a linear

relationship between the gas signal in the cell and the concentration of the gas (in which case only a single-point span calibration is required).

SPAN CALIBRATION IMPOSSIBLE

This message is associated with the span calibration of the water-vapour filter.

The above message indicates that the Monitor cannot calculate the **gas conversion factor**. This could indicate that the concentration of water-vapour used during the calibration was too low – this could either be due to an incorrectly "entered" water-vapour concentration in the set-up of the span calibration or that the concentration of water-vapour used was not the same as that which was "entered" in the set-up.

13.4.2 "Successful*" Error Messages

WATER VAP. MEAS. < OFFSET MEAS

This message is associated with one, or more, of the following calibration tasks: (1) the one- or two-point span calibration of an optical filter; ; (2) the zero-point calibration of all the installed optical filter ("A").

During all the above-listed calibration tasks, the signal in the cell is measured using the water-vapour filter: this enables the Monitor to compensate for any interference signal produced by the presence of any water-vapour in the span gas being used. If the signal in the cell using the water-vapour filter is found to be less than the **concentration offset factor** for the water-vapour filter, the above message is sent.

This could indicate that the zero gas you used, during the zero-point calibration of the water-vapour filter, was **not** perfectly dry.

SPAN MEASUREMENT TOO LOW

This message is associated with the span calibration of one (or more) of the filters.

The above message indicates that the signal measured in the cell during span calibration is less than 3µV and therefore cannot be used to obtain a good calibration. This means that the concentration of your span gas is too low.

SIGNIFICANT CHANGE IN CALIB. FACTORS

This message is associated with the span calibration of one (or more) of the filters.

The above message indicates that the **Conversion factor** calculated during span calibration of a particular filter deviates more than 15% from the **Conversion factor** calculated during the last span calibration of this filter. If you are absolutely sure that the previous span calibration of this filter was correctly performed then this message could indicate:

1. That you have “entered” the wrong concentration for the span-gas in the span calibration set-up.

2. That the concentration of your span gas is not correctly quoted on its “Analysis Certificate”.

3. That there is a leak in the tubing/fittings in your calibration equipment, which alters the concentration of the span gas reaching the cell.

HIGH CONC. SPAN MEASUREMENT TOO LOW

This message is associated with a two-point span calibration task.

The above message indicates that the signal measured during span calibration, when the high concentration of span gas is in the cell, is less than 15µV. This means that the “high” concentration of span gas is too low.

LOW CONC. SPAN MEASUREMENT TOO LOW

This message is associated with a two-point span calibration task.

The above message indicates that the signal measured during span calibration, when the low concentration of span gas is in the cell, is less than 3µV. This means that the “low” concentration of span gas is too low.

Chapter 14

Warning and Error Messages

April 2015

When the Monitor is switched on, and while it is being operated, the Monitor regularly performs a series of self-tests, which check that the various mechanical, electrical and electronic components of the Monitor are functioning correctly. These self-tests are described in more detail in Chapter 5. You can select to disable the **regular self-tests** if desired (see section 5.4.3). If any component is found to be functioning outside of its specifications either a “Warning” or a “Operating-error” message will appear on the gas monitor’s screen.

Please note: A “Warning” and/or “Operating-error” message will only be displayed **once**. If the fault is still found to be present during the next regular self-test the message will **not** be displayed again. Messages are only displayed when a fault is first detected. If the fault corrects itself and then is later found to be faulty the message will be displayed again. It is therefore important to note the message before pressing the **INFO** button, which will cause the error message to be removed from the display.

Although the message is removed from the screen, any gas measurements performed while the fault is still present will be marked with an asterisk (*). By pressing **INFO** when such a measurement is displayed, the **Common mark “O” and/or “W”**, and in some cases, the **Gas Mark “F”** and **Gas Mark “A”** will be shown on the display.

On the following pages, all possible “Warning” messages are listed; all possible “Operating-errors” messages are listed; and all possible “Interface-error” messages are listed. There is a description of each fault as well as the possible cause(s) of each fault. The user must evaluate the significance of each message. As long as the fault is detected, all measurements will be marked by an asterisk. Some “faults” are easily corrected.

Warning and Error Messages

The following table gives most of the error and warning messages contained in the test Hierarchy of the Monitor. There is a description of each fault as well as the possible cause of each fault. The user must evaluate the significance of each message.

Warning Messages	Description of Fault	Possible Cause
AIR FLOW TOO LOW	The air pressure difference created by the pump in the pneumatic (airway) system (tubes and/or analysis cell) is too low. This means that the tubing and/or analysis cell cannot be properly flushed out and the sample in the analysis cell is therefore not necessarily “new”	1. The length of the sampling tube attached to the Monitor’s inlet has been incorrectly entered. 2. Either the external or internal pneumatic system is not air-tight 3. The pump is defective 4. This might also indicate a too high inlet pressure.
AIRWAY-SYSTEM BLOCKED	The air pressure difference created by the pump in the pneumatic (airway) system (tubes and/or analysis cell) is too high	1. The Air inlet is blocked. 2. Air Filter DS0759 blocked.
ALARM LIMIT EXCEEDED	The Monitor has measured a concentration of gas greater than the alarm limit concentration entered	
NO INDEX MARK FROM FILTER CAROUSEL	The Monitor cannot determine the position of its filter carousel	1. The motor that drives the filter carousel is not working 2. The optical detector that checks the movement of the carousel is not working 3. The filter carousel has not been properly mounted

CLOCK SET TO DEFAULT ERROR DETECTED IN CLOCK SETTINGS	The Monitor's internal clock was found to be incorrectly set so these values have been set to their default values	A new battery has been installed
FACTORS SET TO DEFAULT ERROR DETECTED IN CALIBRATION FACTORS	An error has been found in the data stored in the Calibration Factor part of the Monitor's memory, so these factors have been set to their default values	1. A defective back-up battery 2. A defective Working Memory (RAM) or Source Memory (EEPROM) 3. A Software fault
MEMORY SET TO DEFAULT ERROR DETECTED IN BACKGROUND MEMORY	An error has been detected in the Monitor's Background Memory, so the Monitor automatically deletes all data stored in this Memory	1. A defective back-up battery 2. A defective Working memory (RAM) 3. A software fault
MEMORY SET TO DEFAULT ERROR DETECTED IN DISPLAY MEMORY	An error has been detected in the Monitor's Display Memory, so the Monitor automatically deletes all data stored in this memory.	1. A defective back-up battery 2. A defective Working Memory (RAM) 3. A software fault
MEMORY SET TO DEFAULT ERROR DETECTED IN INTERNAL MEMORY	An error has been found in the data stored in the Monitor's internal memory. data stored in this memory cannot be read or altered by the user, so the Monitor automatically corrects any errors found in this memory	1. A defective back-up battery 2. A defective Working Memory (RAM) 3. A software fault.
MEMORY SET TO DEFAULT ERROR DETECTED IN SOURCE MEMORY	An error has been found in the data stored in the Monitor's source memory, so the Monitor automatically gives stored parameters default values.	1. A defective back-up battery 2. A defective Source Memory (EEPROM) 3. A software fault
PARAMETERS SET TO DEFAULT ERROR DETECTED IN CONFIG:/FORMAT PARAMETER	An error has been found in the value parameters stored in the Configuration and/or Format branches of the Monitor's set-up tree, and therefore the Monitor has automatically given these parameters default values	1. A defective back-up battery. 2. A defective Working Memory (RAM) 3. A software fault.
PARAMETERS SET TO DEFAULT ERROR DETECTED IN THE TASK SET_UP PARAMETER	An error has been found in the value parameter stored in the Monitoring Task branch of the Monitor's set-up tree, and has automatically given these parameters default values.	1. A defective back-up battery 2. A defective Working Memory (RAM) 3. A software fault.

X-ON/X-OFF HANDSHAKE CONFLICT	The Monitor receives the handshake signal from the RS232 CTS (clear to send) line, but it has not been set-up to use this CTS line	The Monitor and RS232 device (printer) do not agree about which handshake signal they should use. Perhaps the wrong interface cable has been used.
TIMEOUT. DEVICE NOT CONNECTED	Monitor wishes to send data (data-log or error-log) via the IEEE interface, but there is no response from the device with the address entered in the Monitor set-up	1 No device is connected to the Monitor 2 The device address has been entered incorrectly in the Monitor's set-up.
TIMEOUT. DEVICE NOT READY	Monitor wishes to send data (print, data-log or error-log) but after the start of data transmission, the device stops receiving data.	1. The device is "off-line"(it cannot receive data). 2. The device is not able to receive data fast enough. 3. The device is no longer connected to Monitor.

Error Messages	Description of Fault	Possible Cause
AIR SHUNT BLOCKED. SAMPLE ABORTED	The pressure of air in the analysis cell is too high. The microphones risk being damaged by exposed to such pressure.	The air shunt valve is either defective or blocked.
CHOPPER FAILED	The chopper wheel is not running.	1. The chopper motor is not working 2. The optical sensor which checks the chopper´s movement is not working.
INTERNAL TEMPERATURE OUT OF RANGE	The temperature in the analysis cell is either too high or too low. As the Monitor is operating out-side its temperature specifications, accurate measurements cannot be guaranteed.	1. The ventilation fan is defective. 2. The ambient air temperature is either too high or too low. 3. The temperature sensor is defective.
IR-SOURCE TEMPERATURE OUT OF RANGE	The temperature of the infrared light source is either too high or too low. As the IR-source is oper-ating outside its temperature specifications accurate measurements cannot be guaranteed.	The infra-red light source is defective.
MICROPHONE TEST FAILED	The signal received from the microphone during the self-testing procedure is out of range.	1. The analogue card is defective 2. A microphone (s) is defective.
PUMP TEST FAILED	The pump cannot build up the necessary pressure during the self-testing procedure.	1. The pump is defective. 2. The internal pneumatic system is not airtight.
MODULE STATUS ERROR DETECTED	At least one of the modules is not functioning as expected.	1. Module hardware error. 2. Fault in communication cable 3. Wrong module version 4. Fault in the data configuration of the module

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LumaSense Technologies A/S
Energivej 30
DK-2750 Ballerup, Denmark

Tel.:(+45) 44 20 01 00
Fax: (+45) 44 20 01 01
http://www.lumasenseinc.com